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# THE ROLE OF INDUSTRIAL RESEARCH INSTITUTES IN THE NATIONAL INNOVATION SYSTEM

ERIK ARNOLD, NEIL BROWN, ANNELIE ERIKSSON, TOMMY JANSSON,
ALESSANDRO MUSCIO, JOHANNA NÄHLINDER & RAPELA ZAMAN

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**Author:** Erik Arnold, Neil Brown, Annelie Eriksson, Tommy Jansson, Alessandro Muscio, Johanna Nählinder & Rapela Zaman
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# The Role of Industrial Research Institutes in the National Innovation System

av

Erik Arnold
Neil Brown
Annelie Eriksson
Tommy Jansson
Alessandro Muscio
Johanna Nählinder
Rapela Zaman

## Foreword

VINNOVA has evaluated it's financing of 15 Swedish industrial research institutes, often called the IRECO institutes. The evaluation has included an analysis of the roles of these institutes in the Swedish innovation system. Comparisons have been made with institutes in seven European countries.

The IRECO institutes have been subject to investigations, initiated by the government since 1990, with the objective to reform the institute sector, a work that is still ongoing. In 2006, an investigation was concluded by prof Sverker Sörlin, KTH, aimed at underpinning the government's decisions on ownership, financing and governance.

In 2005, VINNOVA initiated the present evaluation, aimed at guiding it's future decisions on financing of the institutes.

The evaluation issues that VINNOVA formulated were

- to analyse the roles of applied institutes in the Swedish innovation system and, in particular, to distinguish in what ways these roles differ from the roles of the Swedish universities,
- to analyse to what extent the institutes' roles involve cooperation stemming from the needs of Swedish industry,
- to define how extensive the core financing of the institutes needs to be in order to allow them to manage their roles in the Swedish innovation system and to suggest how this financing should be organised.

The evaluation was entrusted Technopolis Ltd, with Erik Arnold, Neil Brown, Annelie Eriksson, Tommy Jansson, Alessandro Musico, Johanna Nählinder and Rapela Zaman as principal investigators.

The evaluation has been supported by a reference group with participants from the Ireco institutes, universities, industry, unions, Ireco, the ministry of industry and the ministry of education. The evaluation has had contacts with the mentioned investigation led by prof Sörlin.

We wish to extend our thanks to the investigators and also to all involved at institutes, companies, universities and others who have made contributions through interviews and questionnaires.

Viewpoints on the analysis will be welcomed, please address them to Göran Yström or Bengt Johansson, responsibles for institute issues at VINNOVA.

VINNOVA in May 2007

*Per Eriksson*
Director General

## Summary

This report documents a study of the role of the Swedish industrial research institutes (essentially, the institutes owned by the Industry Ministry through the IRECO holding company plus SP, the Swedish National Testing and Research Institute) in the innovation system. It is based on interviews, surveys and desk research on the Swedish institutes and on international counterparts and incorporates an evaluation of the institutes' core funding (*k-medel*).

The 'Swedish model' of innovation and research funding for the past sixty years has involved focusing resources on the university sector in the belief that the research system should not be fragmented and that universities can perform not only their traditional roles of teaching and research but also function as society's research institutes. Despite a period of growth in the institute system between World War II and about 1980, Sweden has never financed its applied research institutes in a way comparable to other countries. In recent years it has in practice been disinvesting in them – not only through declining core funding but also through a reduction in the availability of competitively based, state funded research contracts. Several years of institutional rearrangement have not affected these central facts.

This study shows that the institutes in fact play an important role in the innovation system by helping companies move 'one step beyond' their existing capabilities and reducing the risks associated with innovation to allow a faster rate of economic development. Institutes typically use a three step innovation model: building capabilities, using core funding and other resources such as cooperations with universities; extending these in pre-competitive work with industry; and finally using them to deliver services as the technologies mature.

While institutes and universities increasingly overlap and cooperate in knowledge production, they are complements not substitutes, having different skills and core capabilities. Companies normally cooperate with institutes when they need directly applicable knowledge and with universities in order to obtain human resources. There is no evidence to support the 'Swedish model' and the idea that universities can substitute for what institutes do. Industry does not make greater use of universities in Sweden than in other countries, nor do Swedish universities in practice supply the same services as the institutes. Institute-like activities are completely marginal in the Swedish university system.

Swedish research and innovation policy should assign a larger, better-funded and more long-term role to the industrial research institutes, whose role needs to be better integrated into broader innovation policy. Institute managements need a base of resources and strategic freedom in order to

develop and implement strategy. The Swedish institutes' resources for developing capabilities are undoubtedly too small and should be increased. A financing model is needed that combines more core funding with other instruments that encourage the institutes to develop technologies to address social needs, promote interaction with universities, fund participation in international cooperations and provide incentives for internationalisation of the institutes' activities.

# Contents

# 1 Introduction

The role of the industrial research institutes in Sweden has been consistently undervalued and misunderstood since the early 1940s, when committees established by the government and chaired by Gösta Malm produced a series of reports that laid the foundations of the 'Swedish model' of focusing state-funded support for technological innovation on the university system by focusing resources on the development of human capital. In fact, Malm's work also triggered a period of starting and expanding industrial research institutes, but successive reforms led to declining state investment in these, culminating in the idea that the universities should handle not only their traditional tasks of teaching and research but also function as Sweden's research institutes. However, this responsibility was not written into university legislation, and the fact that the so-called Third Task of cooperation (*samverkan*) with society was only finally written into the University Law in 1997 is eloquent testimony to the fact that, while the universities in practice got most of the research money, they never did tackle the institute role.

The high status of the universities and of 'basic' (researcher-initiated) research in the Swedish system means that the extended debate about the role of the institutes in recent years has been conducted largely **in the universities' terms**. The institutes are largely discussed as providing services and doing applied research, **as if** this research were equivalent to the applied research done within universities. Often an implicit or explicit inference is drawn to the effect that the research done in the institutes both could and should be done in the universities. The debate is further complicated by the fact that – notwithstanding the work of the OECD on definitions, especially in the Frascati and Oslo manuals – terminology such as 'basic' and 'applied' research and 'development' is often used differently in different fields and sectors of the economy.

The international literature on industrial research institutes is small and sheds only a little light on what they do in practice, while much of the Swedish debate seems to have been conducted more on the basis of assumption than of evidence. This study therefore aims to make a start on reducing our collective ignorance about what these organisations do, why they do it and whether that is worthwhile. The scope of the study is the IRECO institutes, owned jointly by the state through the Industry Ministry and the Knowledge Foundation. These are the main applied research institutes of relevance to industry. In the last part of the study we also include SP, the Swedish National Testing and Research Institute, whose principal is also the Industry Ministry and which has recently been merged with some IRECO institutes to build the 'Four-Leaf Clover': SP; STFI; SWEREA; and SWICT.

Our report is in five parts. **Chapter 2** summarises the history of Swedish policy for the institutes since 1940 and provides some key facts about the institutes, their funding and their context. It shows that the institutes have had low priority for a long time and that, beginning from a modest base, the state has successively disinvested in the sector for the past quarter of a century.

The defining characteristic of a research institute in the sense of this study – the thing that allows it to support industrial innovation in a way that is not open to the private sector and which, therefore, distinguishes an industrial research institute from a technical consultant – is 'core funding', in the sense of an income stream (whether paid from taxes, an industrial levy, a membership scheme or a combination of these) that funds the institute to build knowledge, which it subsequently uses in support of its innovation support mission. Through the past decades, a number of mechanisms have been used to provide some measure of core funding to the institutes. **Chapter 3** is an evaluation of the latest of these – so-called k-funding (competence development funding) – covering the 3-year period 2003-5. It confirms that that these resources play a central role in generating and refreshing institute competences and in sustaining their role.

Many other countries assign their industrial research institutes a more significant role in the innovation system than Sweden does. **Chapter 4** draws lessons from available information about a number of foreign institutes and institute systems: SINTEF, Norway; GTS, Denmark; VTT, Finland; TNO, Netherlands; IMEC, Belgium; Arsenal Research, Austria; and the Fraunhofer Society in Germany.

**Chapter 5** looks at our six Swedish 'focus' research institutes – ACREO, IVF, SIK, SP, the Swedish Foundry Association and YKI – and explores in more detail what they do in their 'normal' projects not funded by k-funds and what role they play in the Swedish innovation system. Finally, **Chapter 6** draws together a number of policy conclusions relevant for Sweden and for the future funding of the Swedish institutes.

The study is based on a number of surveys and interviews, as well as a reading of background documentation. Where relevant, these are reported in a number of appendices, rather than burdening the main text of the report with the minute detail of the surveys or the full texts of the foreign institute case studies.

The methods we have used in this study were

- Desk review of historical and current documentation, including that relating to the k-funding process and the institutes' plans for using k-funding
- Interviews with the directors of the institutes
- Interviews with a selection of project leaders responsible for doing projects using k-funding
- A questionnaire to all the project leaders of k-funded projects
- Visits to the foreign comparator institutes and face-to-face discussions with senior management in each case
- Questionnaires to project leaders for a sample of non-k-funded projects in the six 'focus' institutes
- Questionnaires to customers of the 'focus' institutes
- Interviews and case studies relating to institute-like activities within KTH, Chalmers and the University of Jönköping
- Interviews with fifteen customers of the 'focus' institutes

We have been supported in our work not only by the directors and personnel of the IRECO institutes and SP, but also by numbers of their customers, IRECO itself and colleagues from VINNOVA, which funded the study. Senior management at a number of institutes outside Sweden generously provided us with time and help. A large and interested reference group followed the work via three meetings in Stockholm, and provided not only support but also kindly criticism – the best and most helpful sort. We are immensely grateful to all the people involved.

# 2 The Research Institute System in Sweden

Sweden has never financed its applied research institutes in a way comparable to other countries, and in recent years it has in practice been disinvesting in them – not only through declining core funding but also through a reduction in the availability of competitively-based, state-funded research contracts. Several years of institutional rearrangement have not affected these central facts. This Chapter summarises the policy and funding history of the institutes in Sweden. [1]

The roots of the current, comparatively minor role of the Swedish industrial applied research institutes in the Swedish innovation system go back at least to the early 1940s and the work of two government-appointed committees chaired by Gösta Malm, respectively dealing with the future of technological research and higher education in Sweden. They had been set up after years of lobbying by the Royal Swedish Academy of Engineering (IVA) and *Industriförbundet*, the employers' association representing manufacturing firms. Malm found that a key problem was a lack of researchers in technology and concluded that the universities' capacity to produce such people should be increased. Rejecting the idea of establishing a central institute of technology, Malm proposed that funding should be aimed at the universities and provided by a technology research council – *Statens tekniska forskningsråd* (TFR) – which the government set up in 1942 at the same time as providing special grants to Sweden's two technical universities: the Royal Institute of Technology (KTH) and Chalmers (CTH). A key effect of setting up a research council was to make the research community responsible for the allocation of resources – a tradition that was continued as the state successively set up research councils in other areas of science and, eventually, also in humanities.

However, Malm also emphasised the need to establish research aimed at meeting the needs of specific branches of industry – notably those that were fragmented and dominated by small companies with limited research resources. As a result, the Institute of Metallography and three new institutes (*Träforskningsinstitutet*, now STFI, a food and canning institute (now SIK) and Textiles) were set up in 1942-5, co-located with the two

[1] The first part of this chapter leans heavily on Sverker Sörlin's excellent study, *En ny institutssektor: En analys av industriforskningsinstitutens villkor och framtid i ett närings- och innovationspolitiskt perspektiv*, report to the Industry Ministry, Stockholm: Royal Institute of Technology (KTH), 20 June 2006

technical universities. Tight links with the universities were ensured by the fact that the institute directors were also university professors (as is normally the case with the Fraunhofer institutes in Germany today) – but this was a practice that was to prove unsustainable in the Swedish university system.

These early institutes that existed to serve the collective research needs of branches of industry were funded through framework agreements between industry and the state. A new institutes for optical research was set up in 1955 at KTH and one for silicates at CTH in 1956. In fiscal year 1959/60, the institutes collectively received 54% of their income from the state via these agreements, 27% from the companies that made up the industry research associations involved, 6% from research councils, only 5% from industrial contracts and 8% from other sources.

The next committee to explore the funding of technological research[2] laboured from 1964 to 1967. Although research at the institutes had grown more quickly than university research since the 1940s, the committee recommended further expansion of the institute system into the 1970s.

The Swedish National Board for Technological Development (STU) was set up in July 1968, replacing TFR with an agency intended to pursue a more active style of research and industry policy, no longer under the control of the research community but effectively governed by a mix of industrial and academic representatives and pursuing an active role as a change agent in the research funding system, with the aim of promoting innovation and industrial development. STU was given responsibility for running the framework contracts with the institutes, providing them with core funding by matching the funds provided by their research association owners. By the mid-1070s, the framework agreements were providing some two thirds of the institutes' total revenues. The institute sector grew from 6 to 32 institutes and research associations[3] between 1960 and 1982 and the state's investment continued to grow through this period (Exhibit 1).

[2] *Branschforskning och forskningssationer*, Fi-stencil 1956:11

[3] Some of the 32 were *programstyrelser* –research associations that bought research on the open market rather than maintaining their own institute

**Exhibit 1 State Funding of Collective Research 1959/60 to 1979/80 (MSEK at 2005 prices)**

| Research | 1959/60 | 1964/65 | 1969/70 | 1974/75 | 1979/80 |
|---|---|---|---|---|---|
| Wood, pulp & paper | 17,1 | 18,8 | 42,8 | 48,0 | 51,0 |
| Food | 6,1 | 7,7 | 14,3 | 10,1 | 14,8 |
| Textiles | 1,9 | 3,3 | 6,9 | 9,7 | 9,0 |
| Metals | 0,2 | 2,5 | 8,7 | 8,3 | 8,1 |
| Optics | 1,4 | 2,0 | 2,5 | 2,5 | 2,3 |
| Silicates | 1,1 | 1,2 | 2,2 | 1,4 | 1,5 |
| Production Engineering | | 8,4 | 10,8 | 11,8 | 19,2 |
| Metallurgy | | | 4,1 | 3,6 | 4,2 |
| Corrosion | | | 3,7 | 4,2 | 7,2 |
| Surface chemistry | | | 1,7 | 3,5 | 3,9 |
| Graphic industry | | | 1,9 | 2,3 | 3,9 |
| Packaging | | | | 6,3 | 9,1 |
| Furniture | | | | 2,5 | 3,6 |
| Glass | | | | 1,8 | 2,2 |
| Rubber & plastics | | | | | 3,4 |
| Total | 27,7 | 43,9 | 100,0 | 116,0 | 140,0 |

***Sources**: Metallforskningskommitténs betänkande (Ds 1961:7), Industriforskningsutredningens betänkande (Fi-stencil 1967:11), Betänkande av STU-kommittén (SOU 1977:64).*

Sörlin points out that the institutes were only one part of Swedish industrial development policy during the post-War period. The other was a series of 'development pairs' in sectors where the state was a powerful actor and where there was a dominant Swedish supplier. Such development pairs included Televerket (the state-owned telephone company) and Ericsson in telecommunications, SJ (the national railways) and ASEA in railway technology, Vattenfall (the state-owned electricity generating company) and ASEA in power generation and transmission – where technologies were co-developed and transferred to the industrial partner. In addition, Sweden had a powerful military-industrial complex, with similar co-development relations, in support of the national policy of armed neutrality. The institutes operated in more fragmented branches of industry where there were no such development pairs. However, from the 1970s, the development pairs began to be broken up and state procurement markets became more open to competition. The defence relationships were further weakened by the desire for a large peace dividend at the end of the Cold War. These relationships have not been replaced. Despite the growth of the institutes in the Post-War period, therefore, their absence from the industries dominated by 'development pairs' meant that the overall size of the institute system was limited to the more fragmented parts of industry.

The expansion of the Swedish higher education system in the 1970s, however, reinforced the overall priority that Malm had given to university-based technology research. Expanding higher education, based on the traditional principle that teaching should be research-based, necessarily drew large amounts of research funding into the university system.

Malm's conclusion that the focus of technological research policy should be on university research was reinforced by a parliamentary decision in 1979[4] that "the universities shall undertake a significant proportion of sector-related research, viz research that aims to support or develop state agencies' activities".[5] The universities were to function as "research institutes for the whole of society". After this point, growth in the number of institutes stopped abruptly. The expansion of the knowledge infrastructure from then on refocused on the universities and the production of qualified manpower. PhDs were then seen primarily as inputs to the higher education system, and not as something needed in industry. Some of STU's activities were cut away in 1990, in order to create a new researcher-controlled TFR. The following year, STU was merged with the national industrial development agency SIND and the energy agency to form NUTEK. The conservative government of the early 1990s set up a number of Wage Earner Foundations[6] in 1994, many providing research funding. When the social democrats returned to power, they cut NUTEK's budget and negotiated the transfer of significant amounts of technology research funding to the new Foundations, especially the Strategic Research Foundation. By this time, there was growing concern that the level of qualifications in Swedish industry was too low. This reinforced the new Foundations' inclination to build centres of excellence and focus on the university sector and the production of PhDs, with only the Knowledge Foundation having a role in research institute funding. The result of these institutional changes was to shift significant parts of technology research funding out of the industry and innovation policy sphere and into areas controlled by the research community. Reforms in the Swedish R&D funding institutions in 2000 further increased the proportion of total R&D funding controlled by the research community, leaving the new innovation agency (VINNOVA – in effect, the successor to STU and NUTEK) as the only part of the system not governed by the academic research community. Unsurprisingly, the fact that university researchers now controlled the governance of most of the Swedish research funding system did not have a positive effect on institute

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[4] SOU 1980:46

[5] Our translation

[6] These have their origins in the so-called 'wage earner funds' set up by the social democrat government of the late 1980s, which used a levy on payrolls to buy shares in major Swedish companies and which were intended over time to share the benefits of ownership with the workers. The conservative government of the early 1990s argued that this was nationalisation by the back door, and used the money so far accumulated to set up Foundations that provided investment funds and sponsored research

funding. However, there was also a clear decline in the amount of competitively acquired project funding made available to them via VINNOVA (Exhibit 2), which argued that this is due to

- VINNOVA's focus on funding new technologies such as biotechnology and ICT, while many of the institutes are focused on more traditional branches
- VINNOVA's focus on developing knowledge in conjunction with universities[7] means that much of the funding has a profile that is not consistent with the institutes' role. The institutes therefore have to compete with the universities on the universities' terms in VINNOVA programmes
- While VINNOVA attempts to induce co-operation between universities and institutes, the absolute sizes of the grants it pays are often too small to make this practical

According to VINNOVA, the institutes would need greater core funding in order to generate the capabilities required to co-operate more closely with the universities.[8]

**Exhibit 2 Project Payments from VINNOVA to IRECO Institutes 2002-4**

| Mkr Institut | 2002 | 2003 | 2004 |
|---|---|---|---|
| ACREO | 58,2 | 76,8 | 64,2 |
| IFP-Sicomp | 5,8 | 6,7 | 4,0 |
| IVF | 49,5 | 32,4 | 19,0 |
| KIMAB | 10,4 | 8,7 | 4,9 |
| Mefos | 5,2 | 4,1 | 1,7 |
| SCI | 1,6 | 0 | 0 |
| SGF | 2,3 | 2,8 | 2,4 |
| SICS | 12,9 | 12,8 | 15,3 |
| SIK | 17,5 | 14,1 | 8,2 |
| STFI/Packforsk/Framkom | 15,5 | 10,4 | 12,2 |
| Trätek | 4,4 | 3,0 | 4,3 |
| YKI | 3,5 | 4,4 | 3,4 |
| TOTAL | 186,6 | 176,2 | 139,6 |

***Source**: VINNOVA Annual Report, 2004*

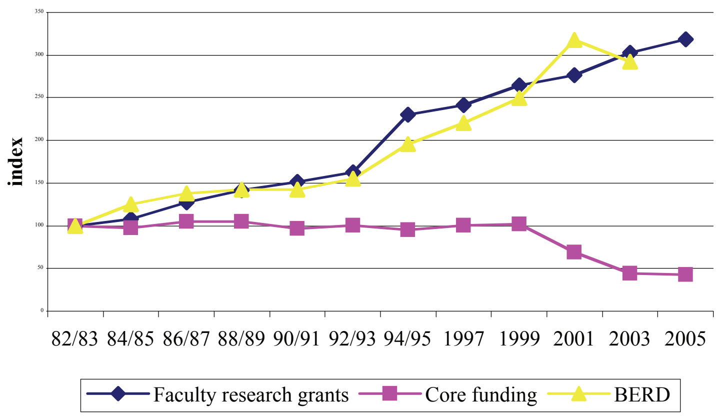
Exhibit 1 shows the effects of the series of funding changes from 1982/3 to date, in the form of indices in real terms of the core funding provided to the institutes, the research component of the General University Fund and the development of business expenditure on R&D in the period. It shows a very

[7] Except where otherwise stated, in this document, 'universities' should be read as '*universitet och högskolor*'

[8] VINNOVA, *Årsredovisning 2004*, VI 2:2005, Stockholm: VINNOVA, 2005, pp27-28

clear picture of a halving in institutes' core funding across a period of massive growth in the university and business research systems.

**Exhibit 3 Index of Institute Core Funding, University Research Funding and Business Expenditure on R&D, 1982/3-2005**




***Source**: Sörlin, 2006*

Over time, the institutes grew but the framework agreements did not (Exhibit 3), so that their importance as sources of income for the institutes has been declining over a long period. The agreements were successively phased out during the 1990s and core funding was provided via a series of short-term agreements.

The Kofi committee[9] (1996) pointed out that the institutes were the subject of continuous debate and study for the ten years before it reported. The institutes have been subject to a series of annual inquiries since then as well as continued debate. Not surprisingly, they are weary of the whole business. The Kofi report led to some changes in the system

- A new funding model was established, which replaced the framework agreements between the institutes and the state. This involved the Industry Ministry paying the institutes 'A-funding' (equivalent to the current k-funding), to help them develop new capacities; and 'B-funding' to support joint projects between the institutes and groups of their members
- The institutes were encouraged to become limited companies, in the belief that this would clarify questions of ownership and responsibility. The KK Foundation took on particular responsibility for supporting them in this task
- Some institutes were provided with a special subsidy in order to help them serve SMEs. This revived earlier programmes funded by NUTEK

[9] *At utveckla industriforskningsinstituten*, Slutbetänkande av Kommittén för omstrukturering och förstärkning and industriforskningsinstituten, SOU 1997:16

- Funding was provided to enable institute staff to take PhDs

IRECO was set up in 1997, as a result of the Kofi report. It is jointly owned by the Swedish state (55%) and the KK Foundation (45%), in order to administer the state's holdings in the applied research institutes traditionally in the domain of the industry ministry. (The ministry separately owned SP, the former state metrology and testing authority,) IRECO's original objective was to promote the competitiveness and restructuring of Swedish industry, but in practice its role has been limited to owning the state's interests in the applied industrial research institutes.

In 1999, four institutes – SP, SIK, IVF and the environmental institute IVL – launched a project to explore the possibility of a merger. Spanning different ministry responsibilities and ownership structures, the path towards merger was difficult, but the project resulted in a marketing alliance called 'United Competence', which remains active (now comprising IVL, SP, SIK and Trätek).

In 2001, the government decided[10] that it should encourage mergers among the institutes, in order to make them more competitive and to change the structure of the institute system from one primarily focused on branches of industry to one where the institutes worked with broader sets of related technologies. Initially, the institutes were encouraged to find their natural partners, and the KK Foundation offered financial incentives to ease such mergers. The 2001 Research Act replaced the 'A' funding for capability development in the institutes with 'K-funding' – which served the same function – and abolished the 'B' funding for collective research. It also provided IRECO with a further 60 MSEK for restructuring the institute sector and the K-funding was subsequently structured to provide further incentives. After a period, IRECO sketched a model of four meta-institutes and suggested which of the old institutes should become part of which 'leaf' of the suggested 'four leaf clover'. Negotiations ensued, in which the institutes effectively decided for themselves where best they would fit, and by 2006 the structure was fully in place. Exhibit 4 shows how the new structure groups the institutes, and the percentage ownership by IRECO. Three institutes – SIK, Trätek and YKI – have as a result left IRECO ownership and are held by the industry ministry and their member companies as subsidiaries of SP.

[10] In the Research Bill, for 2002-2005, *FoU och samverkan i innovationssystemet*, Prop 2001/02:2

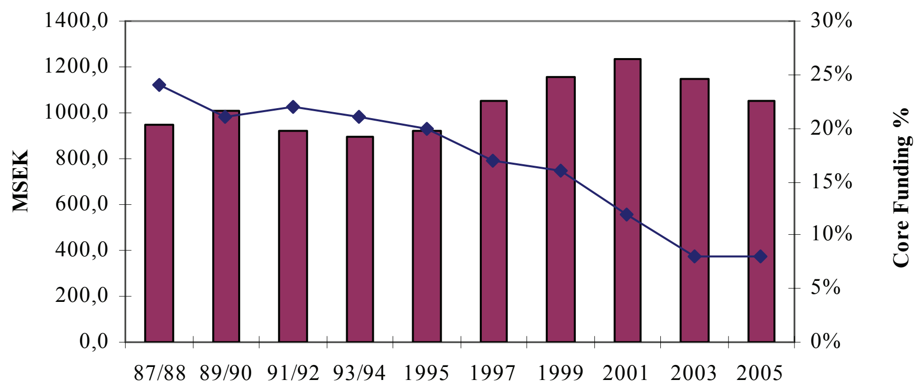
**Exhibit 4 The 'Four-Leaf Clover'**

| Swerea (52%) | Swedish ICT Research (40%) | STFI-Packforsk (29% | SP Swedish National Testing and Research Institute (0%) |
|---|---|---|---|
| Mefos (Metallurgy) | Acreo (electronics and packaging) | STFI (Pulp and paper) | SP (Metrology, testing) |
| KIMAB (Corrosion and metals) | SITI Swedish IT institute, comprising | Packforsk (Packaging) | Trätek (Wood) |
| SGF, Swedish Foundry Association | SICS Swedish Institute of Computer Science | Packforsk Konsult (Packaging) | SIK (Food and biotechnology) |
| IFP (Fibres and textiles) | Interactive Institute (art, design ad IT) | PFI A/S (Norway) | YKI (Surface chemistry) |
| SICOMP (Composite materials) | Santa Anna IT Research (Domestic IT applications) | | |
| IVF (Production engineering) | Viktoria Institute (Applied IT in W Sweden) | | |

***Source**: IRECO, institute websites*

None of these changes affected the state's steady disinvestment in the institutes, which is illustrated graphically in Exhibit 5.

**Exhibit 5 IRECO Institutes' Turnover and Core Funding 1987-2005 (in 2005 MSEK)**




***Source**: Sörlin, 2006*

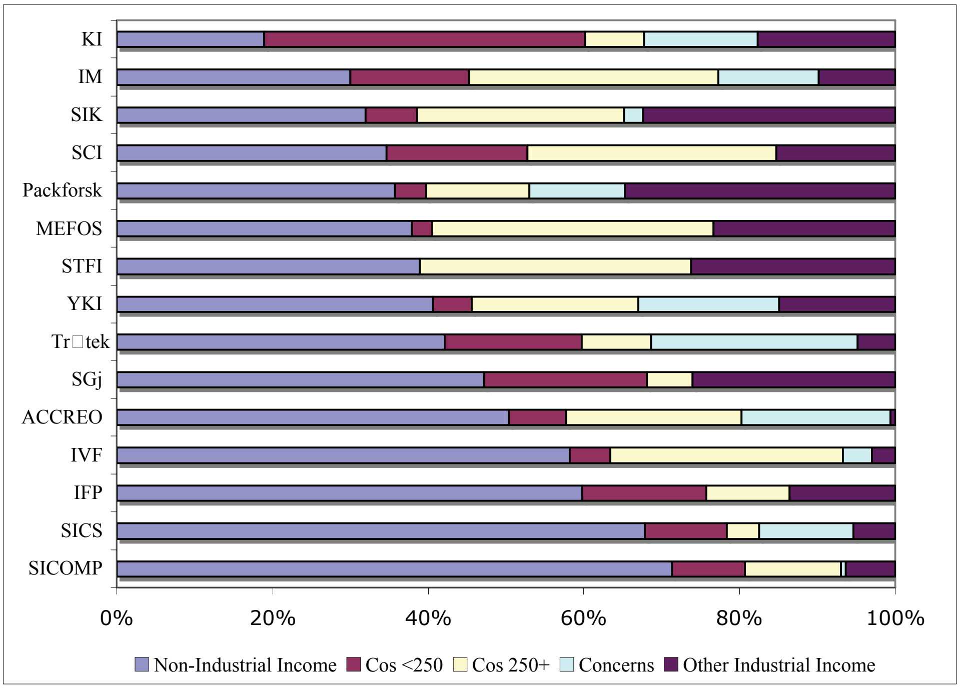
Following several years of discussion about the 'Swedish paradox' – namely, that despite strong Swedish scientific performance, innovation performance and growth were modest – in 2004, the government launched a process of dialogue with industry that resulted in the Innovative Sweden strategy and in increased R&D subsidy for priority branches of industry. This amounted to a key change in the perception of the priority of innovation in overall policy and is clearly reflected in the Research Act of 2005. That underlines the role of the institute sector in making Sweden an attractive place to locate industry and in providing knowledge infrastructure to small as well as large firms and provides a modest increase in core funding. It continues previously allocated K-funding at the rate of 100 MSEK per year for 2006-8. Over and above this, it provides for additional 'strategic' K-funding totalling 155 MSEK for 2007-8: 45 MSEK in 2007 and 110 MSEK in 2008. The Act says that these additional 'strategic' K-funds should

- Contribute to increased cooperation between institutes and universities
- Promote institutes' participation in international R&D programmes, for example within the EU
- Increase institutes' ability to support SMEs' knowledge development
- Contribute to increased cooperation among the institutes and allow greater industrial involvement
- Promote high scientific quality in institute research

The pattern of constant change in the institute sector means there are few usefully long data time series that would enable activity and performance trends to be monitored. For a brief period at the start of this decade, statistics were collected, inter alia about institutes' sources of income.

Exhibit 6 shows the most recent data from this source. For our purpose, these data are not very useful, since they fail to distinguish between core funding and other competitive funding provided to the institutes. They do however show that there was a wide range of levels of public funding to the institutes.

**Exhibit 6 Applied Research Institutes' Incomes, 2003**




*2002 **2001

***Source:** VINNOVA questionnaire data*

Exhibit 7 shows some key figures for the IRECO institutes in 2004, the most recently reported complete year. As the turnover numbers show, the institutes vary considerably in size. Several were operating at a loss – in two cases a significant loss, though they expected to return to profit in 2005. We show the asset bases of the institutes, because these – especially the equity[11] – give a sense of how well the institutes can cope with financial adversity as well as the extent to which they are free to make investments on their own account in developing their businesses. We understand that the financial difficulties of the last few years led some of the institutes to consume part of their own capital, and some have been left fragile as a result.[12] The final column of Exhibit 7 shows k-funding as a proportion of turnover and indicates that there was a range of funding in 2004 between 5% and 11% of turnover, with a weighted average level of under 8%.

[11] 'Own capital' or shareholders'; funds

[12] Some countries have business support instruments that strengthen companies' equity, because this provides the maximum of flexibility to the entrepreneur in making use of subsidy or loans support. A similar approach could be an option for supporting the institutes, maximising their ability to make flexible use of the support

**Exhibit 7 Key Figures for IRECO Institutes, 2004 (MSEK)**

| Institute | Turnover | Net profit | Total Assets | Equity | K-funds | Return on Sales | Equity/ Assets | Equity/ Turnover | K-funds/ Turnover |
|---|---|---|---|---|---|---|---|---|---|
| ACREO | 212.6 | 3.6 | 109.9 | 26.7 | 16.8 | 2% | 24% | 13% | 8% |
| IFP-SICOMP | 53.7 | -3.2 | 51.5 | 15.2 | 3.0 | -6% | 30% | 28% | 6% |
| IVF | 105.3 | -14.7 | 50.5 | 12.6 | 5.1 | -14% | 25% | 12% | 5% |
| KIMAB* | 125.4 | 1.6 | 126.4 | 92.2 | 6.6 | 1% | 73% | 74% | 5% |
| Mefos | 95.2 | 0.0 | 51.8 | 6.5 | 5.3 | 0% | 13% | 7% | 6% |
| SCI | 10.6 | -1.7 | 3.9 | 0.2 | 0.9 | -16% | 5% | 2% | 8% |
| SGF | 30.5 | 0.6 | 24.3 | 16.9 | 2.7 | 2% | 70% | 55% | 9% |
| SICS | 80.3 | 0.3 | 57.3 | 22.2 | 8.6 | 0% | 39% | 28% | 11% |
| SIK | 100.6 | 2.2 | 70.6 | 18.5 | 8.2 | 2% | 26% | 18% | 8% |
| STFI+ | 273.6 | 7.6 | 130.5 | 38.0 | 21.4 | 3% | 29% | 14% | 8% |
| Trätek | 44.3 | | | | 4.5 | | | | 10% |
| YKI | 60.5 | -8.0 | 46.7 | 13.5 | 6.8 | -13% | 29% | 22% | 11% |

* Includes turnover of the Corrosion Institute Jan-June 2004, before it became a subsidiary of KIMAB

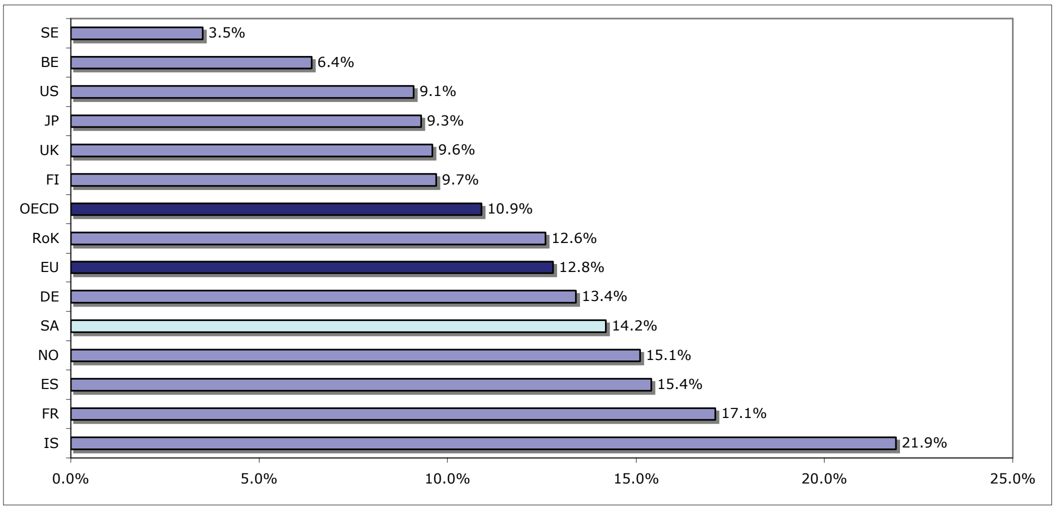
+ Includes Packforsk and Framkom

***Source**: IRECO*

The effects of these developments are shown starkly in Exhibit , which shows the proportion of countries' Gross Expenditure on R&D that is spent by government outside the higher education system. (This is the nearest approximation to state spending through research institutes that is available in international R&D statistics.) Sweden is the outlier. It spends less than a quarter as much (normalised for GDP) on its institutes as the EU-15 average. The result of Sweden's modest post-War investment and its later **dis**investment in the institutes, combined with the disappearance of the ' development pairs' is today's "bipolar" landscape[13], with higher than internationally usual levels of investment in R&D in the university and industry sectors and a "desert" in between, where other countries have a strong research institute sector.

[13] Sverker Sörlin, *Institutssektorn, högskolan och det svenska innovationslandskapet*, Arbetsrapport 2004:31, Stockholm: SISTER, 2004

**Exhibit 8 GOVERD as a Proportion of GERD, 2003 or Most Recent Year**[14]




*Source:: OECD, Main Science and Technology Indicators, 2006*

There is no evidence that industry in Sweden is prepared to go along with the bipolar 'Swedish model' and work disproportionately with the university sector. As in other countries, there has been an increase in industry's share of university research incomes between 1981 and 2001, but the change in the second half of the period, from 1991 to 2004, has been minimal: a rise from 5.2% to 5.5%[15], compared with the OECD average of 5.7%. Sörlin[16] points out that even KTH – the university most seriously networked with industry – only obtains 7% of its research income from industrial sources. Of this, 2% come in the form of contracts to perform research and the remaining 5% are in the form of corporate memberships and contributions to competence centres and other kinds of consortia.

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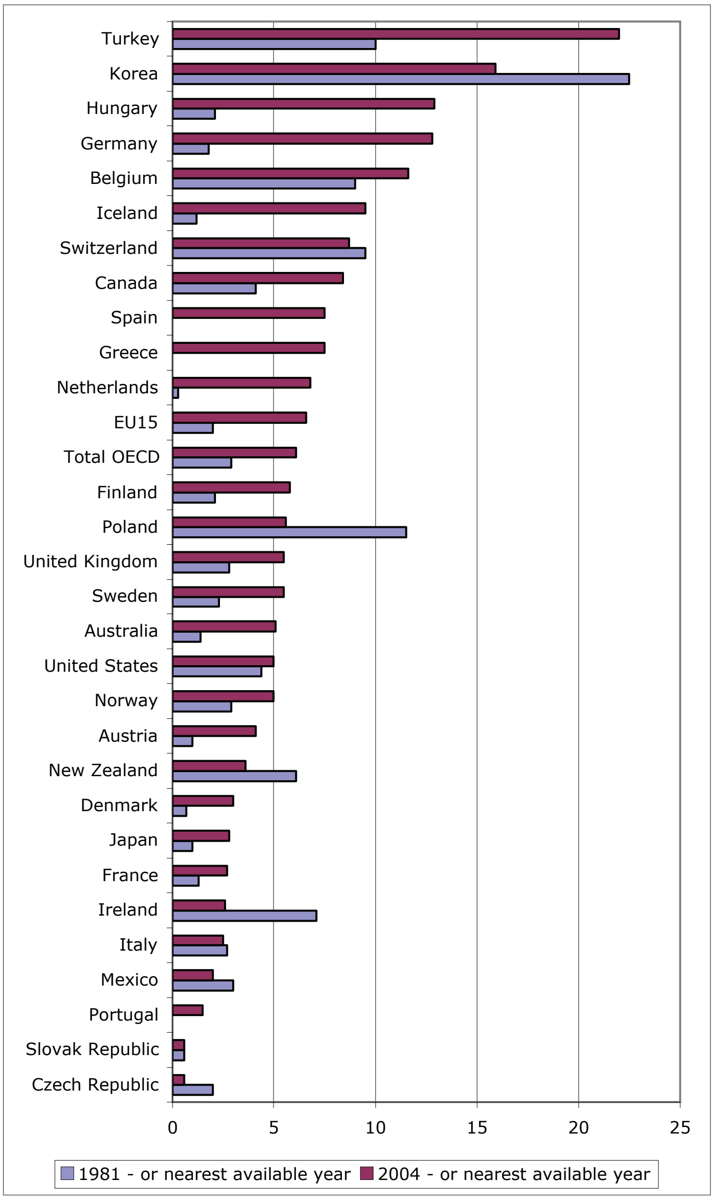
[14] Reproduced from E Anders Eriksson and Nils Markusson, *Näringsliverelevanta forskningsinstitut – svenska val i europeisk belysning*, (mimeo), Stockholm: VINNOVA, 2004

[15] *OECD Main Science Indicators 2005/1*

[16] 2006

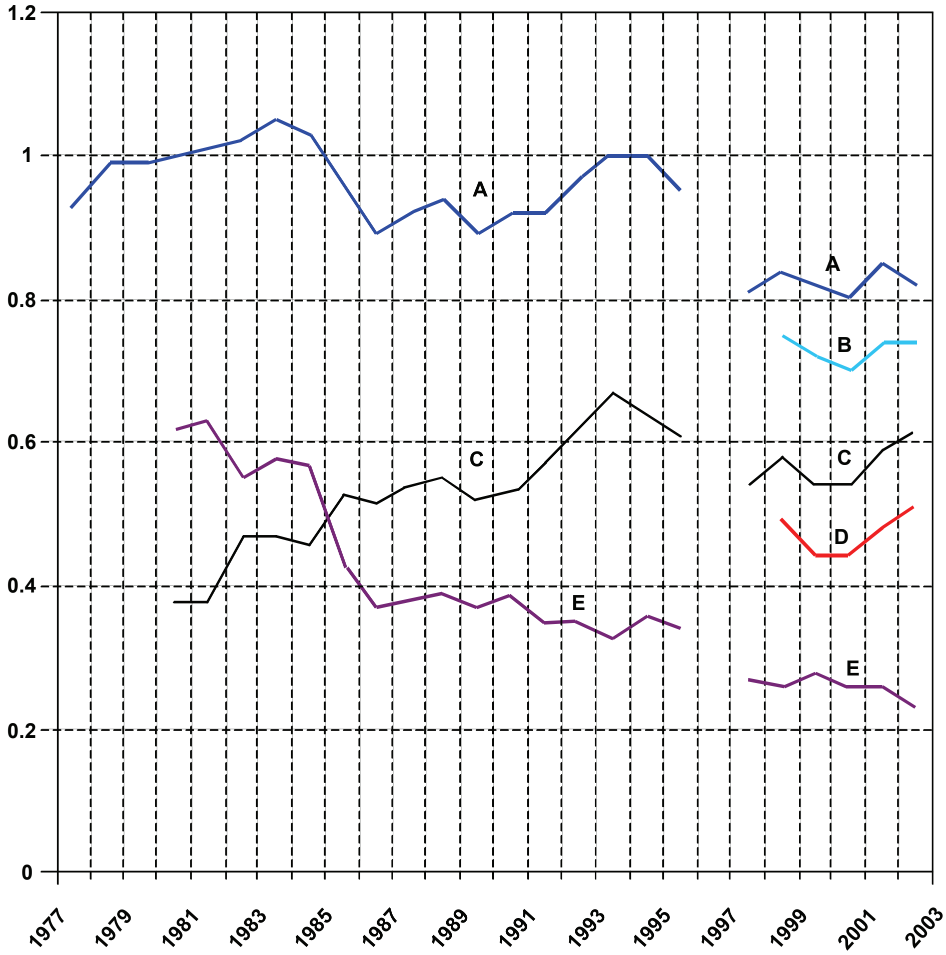
**Exhibit 9 Percent of HERD Financed by Industry, 1981 and 2004**




***Source****: OECD, Governance of Public Research: Towards Better Practices, Paris: OECD, 2003; Main Science and Technology Indicators, 2006*

Indeed, rather than the university sector convincingly taking on the roles elsewhere performed by institutes, there is strong evidence that the state funding system as a whole is reducing its commitment to 'use-oriented' R&D in relative terms (Exhibit 10).

**Exhibit 10 Trends in state R&D funding, 3-year moving averages, 1977-2002 in % of GDP**




A  Total state funding of civil R&D
B  A, minus funding by the Wage Earner Foundations
C  'General scientific capacity building'
D  C, minus funding by the Wage Earner Foundations
E  Other civil objectives, ie use-oriented research, broadly defined

***Source****: SCB data analysed by Göran Reitberger, published in Sörlin, 2004*

# 3 Core Funding of the IRECO Institutes and How it is Used

This Chapter explores how the IRECO institutes used the core funding provided to them in 2003-5, in the form of ‘k-funds’. It shows that these funds are key to the institutes’ role in the innovation system, as actors operating in the public interest and outside the constraints that operate on private firms, and to directors’ ability to run and operate strategies for their institutes. K-funds fuel the institutes’ internal innovation cycle, building the platforms and competences they need in order to be useful to industry. K-funded work spans applied research and development but can also include aspects of foresight and market research. Projects are often collaborative and half of them involve doctorands, connecting the institutes into the world of university research. By and large, they incrementally extend the scope of the institutes’ operations. They appear to be less risky than might be desirable, as institutes carefully husband scarce k-resources. They lead to publications as well as internal knowledge and underpin institutes’ future income from business. In many cases, industrial members of the institute contribute to the pool of resources used to develop capabilities. However, codetermination by industry of the use of this money appears to promote lock-ins. Broadly, the core funding is crucial to the institutes but the level of funding is too low and the lack of a long-term institutes policy hampers the planning and the activities of the institutes.

In order to make the Chapter more readable, we have relegated some of the more detailed charts and information relating to this Chapter are provided in the Appendix.

## 3.1 K-funds 2003-5

The purposes of the k-funding round in 2003-5 were set out in a letter inviting the institutes to apply. These were long-term capability development

- So that each institute or group of institutes creates excellent industrially relevant capabilities in one or more areas
- To help the institutes strengthen their role in the innovation system
- To enable the institute system to develop and to be nationally and internationally competitive
- To renew existing areas of knowledge and to develop new ones

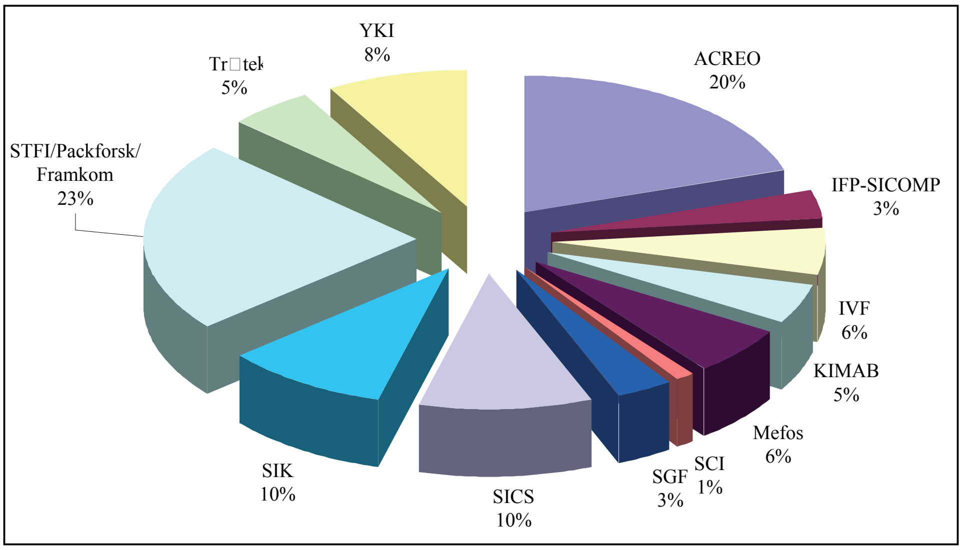
- To promote cooperation and knowledge exchange with industry, other institutes and universities in Sweden as well as with sources of knowledge abroad

The k-funds for the first quarter of 2003 were allocated initially in an arbitrary block of 25MSEK to the institutes, so that each obtained 2% of its turnover in that quarter, while a more structured assessment process was put in place. A Programme Committee was created, under the chairmanship of Anders Narvinger, chair of IRECO, and was delegated the authority to take the needed funding decisions. The committee took an overall decision of principle that no institute should receive an amount equal to less than 4% or more than 11% of its turnover. Independent experts were asked to score the institutes' applications according to the criteria set out above. The committee then reviewed these scores and allocated the available funds.

A total of 350 MSEK in K-funding was allocated for the period 2003-5. While all the money originated with the Industry Ministry, 50 MSEK was allocated via the IRECO budget and the rest via VINNOVA. Most of the money was allocated competitively to the existing IRECO institutes. Some 75 MSEK were held back to help fund the restructuring of the institutes into fewer, larger entities. The shape of the desired merger was not clear when the K-funding was originally voted in the national budget but during the funding period the idea of the 'four-leaf clover' was developed and the bulk of the money was effectively allocated to the four new meta-institutes, based on a judgement about their respective needs rather than a competition. As the managements of the new institutes have been put into place, so they have been given control over the internal allocation of the remaining 'restructuring' component of the K-funding among the old IRECO institutes. In this study, we have focused on the MSEK 275 that went to the old institutes, rather than the exceptional restructuring money, since the objective of our work is to inform the future level and use of K-funding.

The institutes used the money in different ways. In some cases (SICS is an extreme example) much of the money went to co-finance participation in EU Framework projects. Others used the money to 100%-finance their own development efforts. Yet others matched the K-funding with money from their member organisations in order to fund internal development projects.

**Exhibit 11 K-funding Agreed with IRECO Institutes Q3 2003-Q4 2005**




***Source**: Plans agreed between individual institutes and VINNOVA, 2003*

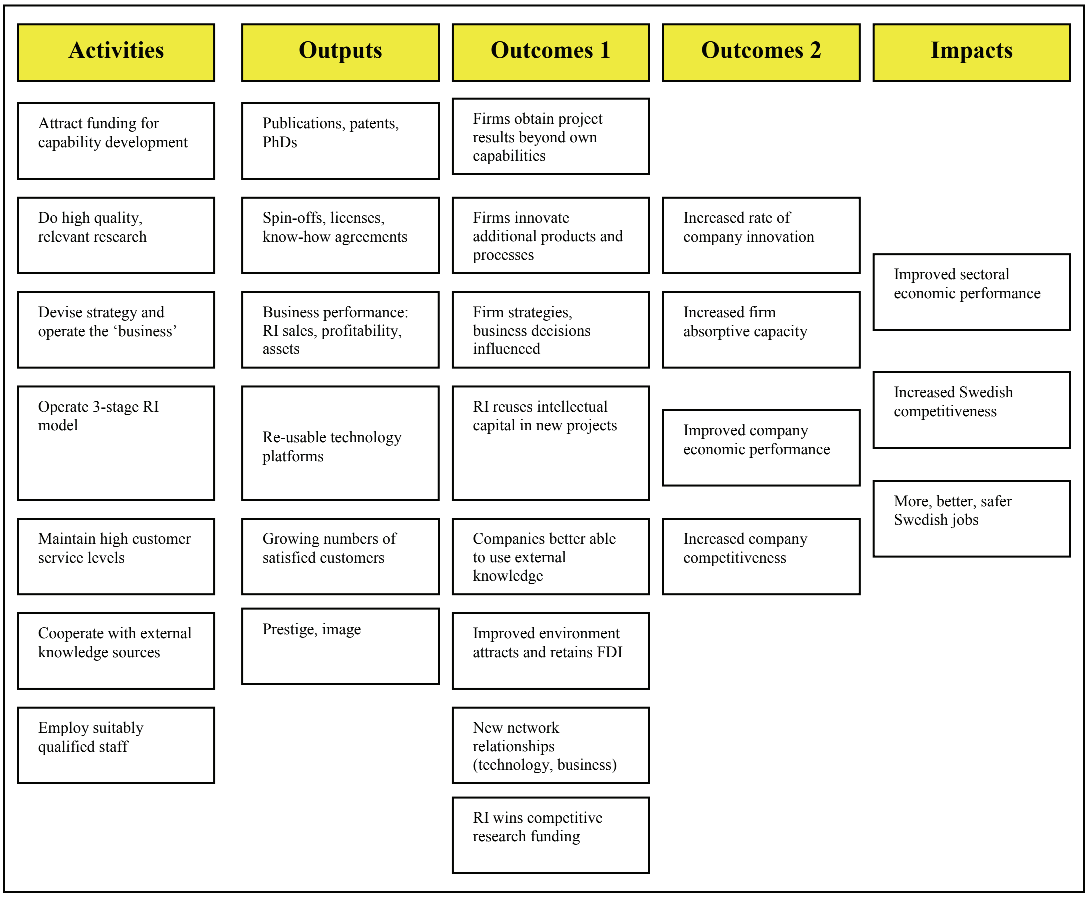
## 3.2 Core funding in principle

Since the overriding purpose of industrial research institutes is to promote industrial competitiveness by technological means, they can only do their job if they in fact are technologically capable and can offer firms inputs that are in advance of or otherwise superior to those available on accessible commercial knowledge markets. Core or 'capability' funding exists in order to fund this advantage. It represents a social investment and society expects to get returns through spillovers. That is, the institute's technological advantages are passed on to its customers whose performance improves, become more competitive, employ more people, pay more taxes, increase the quality of life, and so on.

Private companies operating without subsidy struggle to obtain such advantages. Where they do, it is irrational for them to share them with others. Rather, they try to prevent spillovers through monopolising advantages and earning super-normal profits. There is no market solution to the national need for institutes. In fact, the nearest private sector equivalents to industrial institutes – engineering consultants – famously struggle to do any R&D at all. Even though such firms tend to want to invest in new capabilities, price competition for new projects tends to squeeze this out. Clients are rarely interested in their suppliers' future ability to do work, and are certainly unwilling to invest in it. Human mobility is generally the most important external source of new capability for such firms.

Exhibit 12 summarises the overall logic for the state to intervene in the innovation system by investing in research institutes, as it emerges from this study.

**Exhibit 12 Logic Diagram for Institute Funding**




Both this logic and practical experience – for example from the period when the UK government withdrew funding from the research associations – suggest that withdrawing core or capabilities funding from a research institute will over time turn it into a technical consultancy, as it is forced to obey the market's rules.[17] Of course, technical consultancies can be good and useful things, but the state has no need to own or run them – the market organises that quite well without any help.

In principle, the more money an institute can invest in research to produce capabilities, the further away from its customers' short-term needs it can search for technological opportunities. Given enough money, it no longer needs customers and it becomes in a literal sense irrelevant to the economy. Between these two extremes of curiosity-driven research and technical consulting lies a spectrum of possible real positions.

[17] See the case study of the privatisation of the UK Prduction Engineering Research Association (PERA) in Howard Rush, Michael Hobday, John Bessant, Erik Arnold and Robin Murray, *Technology Institutes: Strategies for Best Practice*, London: International Thomson Business Press, 1996

## 3.3 Core funding in institute management

The directors of all the IRECO institutes kindly agreed to be interviewed for this study. We used a semi-structured approach to try to ensure that we both covered the necessary issues and at the same time were open enough to be surprised by things we had not anticipated.

One clear message was that the institutes have experienced significant financial difficulties in the past few years and that they have been forced to rationalise their activities. We were told that total employment in the IRECO institutes had fallen by 25% in the period 2002-5. The ‘dot-com bust’ of the early 2000s has been a factor, especially for those institutes directly exposed to the ICT industry, but there has also been a significant disinvestment by the state. The so-called B-funding for ‘semi-collective’ R&D, which laid the ground for future industry-funded projects in the institutes, was phased out during 2000-2. Directors said this represented the loss of a useful instrument for transferring capabilities to the company sector, and especially for generating the absorptive capacity for companies to work – with or without the institutes’ help – on certain new technologies.

However, much more important was the loss of project-based income from VINNOVA and its predecessor, NUTEK’s Teknik division. Historically, a significant proportion of the project funding from NUTEK was allocated ‘bottom up’. It was possible to take new ideas to NUTEK and, subject to satisfactory review, negotiate funding, almost irrespective of the subject of the project. This had been a useful complement to the core funding arrangements of the 1990s, in practice extending the amount of capability-building the institutes could do.

The transition from NUTEK to VINNOVA had led to three important changes. First, VINNOVA was seen as very under-funded and as starting life with a budget that had already been fully committed by NUTEK, so the agency was absolutely short of money. Second, partly as a result of this and partly caused by the style of the new agency, bottom-up funding was quickly squeezed out of VINNOVA’s portfolio. The growing focus on new technologies reduced the fit between VINNOVA’s priorities and the institutes, many of whose roots are in established branches of industry. Third, VINNOVA’s proposal assessment criteria and performance indicators focused on the types of R&D conducted in the universities. And a number of directors sourly added that ‘VINNOVA often requires us to have a university partner when applying for funding, but they never require the universities to work with us.’

SIK told us that their turnover at the start of the 1990s was about 33 MSEK, of which a NUTEK framework programme provided about one third. The institute grew to a turnover of 115 MSEK in 2002, from which it has since fallen back to 100 MSEK, yet the effective core funding (K-medel) in 2004 was just over 8 MSEK in current money. The metals institute (now part of KIMAB) said its income from NUTEK/VINNOVA had fallen from 27% of turnover in 1998 to 13% in 2003 and to less than 10% today. In a similar period, NUTEK/VINNOVA funding of SGA had declined from 25% of turnover to some 10%. More broadly, YKI had moved from being 60% state funded in 2001 to 40% in 2005.

It is clear that there has been a significant disinvestment by the state in the institute sector in recent years and also that this disinvestment has partly been an unintended consequence of changes in the organisation of R&D and innovation funding in Sweden and the way new funding institutions have interpreted their mission. It is not clear that this disinvestment was a considered **policy**, not least because the state has allocated significant responsibilities for the institutes to VINNOVA, IRECO and the KK Foundation during the period in question.[18] Rather, it is a damaging side effect of the lack of research and innovation policy **resources** at the ministry level in the Swedish system – a lack that we elsewhere argue has also hindered the formation of other policies and the effective use of Sweden's considerable investment in technology foresight.[19]

The institutes have been transformed from foundations into limited companies in recent years, but this change in form is comparatively unimportant compared with the real economic environment in which they operate. The reduction in state support increases the pressure on the directors to run their institutes as businesses. The fact that most of the institutes were historically research associations and that they therefore still have fee-paying members who exercise some control over what the institutes do is in some ways positive. It forces each institute to confront the expressed needs of one part of industry and generates a flow of income that can sometimes be used to build capacities that are relevant to the members and sometimes to do other things, such as disseminating new information. But the memberships also tend to lock in the institutes to the old branch structure and the old questions.

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[18] It is worth noting that this fragmentation of responsibility is in marked contrast to the more centralised structure used in Norway, where funding for the industrial institutes flows entirely through RCN, and to the way some other countries use large institute systems (eg TNO, Fraunhofer, VTT) to manage and create continuity on their institutes

[19] Erik Arnold, Sven Faugert, Annelie Eriksson and Vincent Charlet, *Från Framsyn till Samsyn: An Evaluation of the Second Round of Swedish Technology Foresight, Teknisk Framsyn, 2002-4*, Stockholm: Teknisk Framsyn, 2005

As the economic environment gets tougher, the pressure from the members for the institutes to serve their own needs rather than pursuing new technologies and opportunities means that institutes have to follow (from a pure business perspective) sub-optimal strategies, increasing further the economic pressure under which they live and causing their collective offerings to diverge from overall national needs. Both in terms of economic survival and national interest, therefore, the directors need to find ways to **disempower the membership** of their respective institutions so that they can pursue rational business strategies. This does not mean disregarding the membership, who continue to provide the institutes with a base load of activity and vital information about needs and industrial realities. But it does mean that the directors have to acquire a degree of strategic freedom to run their business that was less important in former times. As one director put it, "K-funding provides breathing space for us. It's the only money that's not over-constrained. The money is used largely independently of the industrial interests for which we work and lets us get into new fields."

It if often assumed that part of the role of the institutes is to serve SME needs. Since many SMEs typically have less absorptive capacity than large firms, they tend to need to obtain technology in more of a ready-packaged form than large companies, which have plenty of engineers and scientists in-house. From a business perspective, however, SMEs are generally poor customers. Their limited capabilities mean that it is expensive to sell to them. They have few resources and so can only buy small pieces of work, which tend to be unprofitable for the institute. They are also often unwilling or unable to pay the cost-based prices normally charged by the institutes. SME service is therefore subsidised in many countries, and several directors welcomed the news that VINNOVA intends to re-launch a funding scheme to subsidise use of the institutes by SMEs. This will allow the institutes to play an important social role without at the same time financially penalising them.

The directors manage under a number of other constraints. They have to satisfy those who pay for capability development that they are doing sufficiently generic research to justify a subsidy. The ability to do interesting research is also an important element in staff motivation. They need to match the bulk of what the institute does to industrial need. As recipients of subsidy they need to avoid direct competition with private consulting and technical services suppliers. As one director put it, running an institute is "not a maximisation but an optimisation across academic value and benefit to industry".

A key difference between institutes and many universities is the need to programme activities. This is partly caused by the need – which varies among institutes – to obtain a financial return on expensive equipment, especially pilot scale facilities that allow the institute to tackle real industrial problems. Many institutes act as 'knowledge bearers' for their branches, maintaining key databases, influencing standards and holding libraries of industry-relevant materials. The need to programme is also partly caused by the requirement to match customers' specific needs, rather than to generate new knowledge in areas chosen by the researchers themselves. In order to use knowledge to help others, institutes need to consider not only knowledge generation (or acquisition) but how to codify and exploit it at various scales. Most operate with an explicit or implicit innovation model that involves

- Exploratory research and development to develop an area of capability or a technology platform
- Further work to refine and exploit that knowledge in relatively unstandardised ways, often in collaborative projects with industry
- More routinised exploitation of the knowledge, including via consulting

A now-retired generation of IVF managers used to compare the institute's activities to a three-stage rocket, with the respective stages being: technology monitoring and acquisition; development; technology transfer.[20] The rocket analogy may be anachronistic but is still valid. A key difference among institutes is the extent to which technologies are acquired from outside the institute or developed internally. IVF is at one extreme, effectively 'importing' a lot of the technologies it exploits. YKI, SICS and SIK are towards the other end of the spectrum, as is clear from the quite large number of PhD students involved in their activities. Alarmingly, institutes that have been large employers or hosts of PhDs such as SICS, SIK and YKI said that the numbers of PhDs at the institute were declining.

In practice the institutes plan their strategies taking their members' needs carefully into account. The formality of their planning exercises varies, but normally involves both internal reflection and consultation with customers or members. Some also do more formal market and state of the art studies. SIK and Trätek explicitly use 'visions' – for example, of the Food Factory of the Future and the Modern Wooden Town – as devices to focus and communicate their research strategies.

The use of k-funding is planned in ways similar to the overall strategies. The proposals to VINNOVA for k-funding in the period 2003-5 were produced in a standard format that explicitly explained how they related to institute strategy. There is little explicit consultation with academia – though

[20] Howard Rush, Michael Hobday, John Bessant, Erik Arnold and Robin Murray, *Technology Institutes: Strategies for Best Practice*, London: International Thomson Business Press, 1996

it should be remembered that the institutes that depend on research to generate their new technological capabilities tend to have quite good university links, and all the institutes have at least a small level of cooperation with a university. They therefore have good access to an academic view of the state of the art in fields relevant to them.

K-funds are not the only source of money that can potentially be used for capability development, though there is no such thing as a free lunch – all sources of money come with conditions. Sometimes it is possible to reinvest institute income from routine projects in building new capabilities, though many of the institutes have suffered from poor finances in recent years. Some institutes can use some of the membership fee income they receive, though in these cases the members usually have a strong voice in deciding how the money is used. Swedish research and innovation funding agencies are potential sources of money for developing capabilities, but tend to be more interested in the second stage of 'scaling up' and exploiting technologies in collaboration with industrial users than the first, exploratory stage. The focus of many of the funders on university 'basic' research means that the possibility for the institutes to get money from them is rather theoretical. YKI is to a limited extent able to generate licence income from intellectual property, but in most cases any intellectual property rights that the institutes produce belong to their company partners; otherwise, the institutes would find themselves in the uncomfortable situation of competing with their customers. Unlike in Denmark, where the system of centre or innovation contracts teams company, university and institute researchers to solve industrial problems in ways that produce reusable intellectual capital for the institutes, there is no innovation policy funding instrument dedicated to producing capabilities in the institutes.

Many of the institutes view EU projects, especially those in the Framework Programmes, as potential opportunities for capacity development (as well as being important arenas for business and technical networking). However, given the low success rate of applications to the Frameworks, these are not reliable sources of development money. The fact that they only cover 50% or so of participants' costs[21] means that they tend to consume k-funds to provide co-financing, rather than generating additional income. K-funding is therefore the only reliable source of capabilities funding.

The directors tended to see the three-year planning cycle used in k- and other funding in Sweden as problematic. The competitive applications to VINNOVA for k-funds involved tying the institute to a particular plan for using the money across a quite long period, while the institutes reviewed

[21] This will rise to 75% in the Seventh Framework Programme

and reprioritised their capability-building efforts at least annually and often more frequently, in order to stay in touch with changing industrial requirements. The felt need was to be able to plan for longer periods such as three years, but to be able to update the plans annually. In order to achieve something like this, some directors explicitly created a small budget line for working with new and unexpected opportunities within their k-funding applications; others said they ‘cheated’ in various ways, in order to create the needed flexibility.

We invited the directors to take a ‘zero-based budget’ approach to capabilities funding, to propose what the right level of competence funding would be for their institute and to argue why this, and not some other, was the right level. Most struggled with the question, and many fell back on the idea that they should get the same core funding as their continental competitors, which they believed to be about 30%. The range suggested was from 20% to 50%. In so far as there was a pattern in the responses, it seemed to follow the research-intensity of the industries served by the institutes and the extent to which the institutes produce new knowledge in-house. Thus, electronics-related institutes that employed PhDs suggested higher numbers while those more focused on mechanical production and the re-use of existing knowledge suggested lower ones. The extent to which institutes were able to ‘harvest’ the fruits of their investments by providing consulting and other more routine services late on the life cycle was another relevant factor. SICS, for example, felt largely excluded from consulting because there is a highly-developed software consulting sector, while SGA was more able to generate consulting income because few others provided equivalent services to foundries.

Overall, the directors told us that k-funding is a vital and largely unique source of renewal and development. It provides them with a strategic resource that helps them shape the direction of their institutes and offers a degree of *Planungssicherheit* not available from other sources. Not surprisingly, there was universal agreement that the current level of k-funding is inadequate.

## 3.4 K-funding in Institute Strategies

The greater number of the institutes planned to use k-funding in conjunction with a contribution (typically about 25% of capability development funds, but ranging from 17-44%) from their member companies.

Responding to VINNOVA’s desire for clear planning, few explicitly built in a reserve of money to allow them to tackle unexpected new developments and opportunities. In summary, the institutes planned to used the k-funding as follows

- ACREO set out a programme comprising two major efforts, in biotechnology and nano-technological systems, in order to extend into new fields and build new technology platforms. It also held back a part of the funding to tackle 'hot topics.'
- IFP-SICOMP set up three internal groups to tackle emerging issues in process science, functional modification of polymer systems and lifetime and dimensioning. Initially, it set up two projects in each area, but the plan allowed for later variations
- IVF decided to strengthen its capabilities in three areas – micro-systems, design of light structures and flexible low-volume manufacture – which it judged both to be of importance to the Swedish engineering industry and to be areas where IVF itself had or could develop a significant strength. Its plan was very clear that the objective of these activities was to develop capabilities for which it could charge money
- KIMAB used the k-funding to deepen its knowledge in several areas of emerging importance in corrosion prevention and the use of metals, notably non-ferrous metals: corrosion in polymeric materials; light metal structures in engineering; alternative energy production; environmentally-friendly surface treatment; anti-corrosion and anti-fouling for marine applications
- Mefos used the money partly to experiment with national and international collaboration (stressing that some of the key developments in reducing the environmental load of metals production are being pursued at the European and global levels). Its work focused on: developing process technology for sustainable metals production; waste materials treatment and exploitation; modelling and simulation for metals production; measurement and control for metallurgical processing technologies
- SCI, the ceramics institute, sought to develop a wide range of new capabilities, partly in cooperation with YKI. These comprised: fuel cell technology; electronics manufacture, sensors, separation and analysis techniques for biotechnology, bioceramics for dental and orthopaedic applications; and materials for optical filters. The strategic aim was to offer new kinds of knowledge to existing customers while drawing in new customers to the institute's core areas
- The Swedish Foundries Association (SFA) put in place a programme of capability development in parallel with a longer-running effort to support and participate in the development of the Casting Innovation Centre at the University of Jönköping – a joint effort with the university to provide a locally-based, longer-term research relationship for the institute. It increased the size of the group working with materials technology to create integrated functions in light structures for 5 to 8 people; did more work on simulation to speed up design and underpin more flexible manufacture; and work on more resource-efficient production with better use of waste materials

- Under the influence of its membership, which provided some 30% cofinancing, SICS used the greater part of its considerable (25 MSEK) k-funding to develop further its capabilities in the two core areas of ICT software and Industrial IT. Some 1.5 MSEK were held back for new areas. This outcome reflects a measure of disagreement between the members and the institute management about the desirability of further diversifying the institute's capabilities, following the drop in demand for its services in the early 2000s, as a consequence of the 'dot com bust' when many IT companies (not least Ericsson) cut back their R&D spending
- SIK's strategy was further to develop existing capabilities, focusing on keeping up to date via three themes: product design for tomorrow; product safety and consumer confidence; and the food factory of the future
- STFI very consciously allocated part of its k-funding to business development, in the belief that this is crucial both to understanding the changing patterns of needs and demands and also to running the institute in such a way that it could achieve its business targets and remain financially healthy. This was especially an issue at STFI, since a generation change was in process, involving the retirement of several of the most experienced people. STFI therefore focused on technologies that would stretch its existing core capabilities: IT use in the supply chain; green materials; customer perceptions of paper and packaging products; new print media, such as digital printing, new packaging printing techniques and printed electronics. In the business area it worked on: foresight; management of large projects; developing an Intellectual property Rights (IPR) management system; and human resource development. In addition, it tackled systemic methods for working with sustainable development at the institute
- Trätek focused its k-funded work on the theme of "the modern wooden town", especially in relation to damp-proof design and construction safe and healthy living in wooden buildings (taking into account aspects such as emissions and fire hazards) and tools for balancing building life against environmental loading. These foci also required that aspects of the work involve the use of wood in combination with other materials and developing new products for both the professional and the self-build sectors
- YKI is working together with several universities and two other research institutes significantly to extend its innovation capabilities in
  - New concepts for biotechnological analysis in miniaturised systems, aiming to develop new and competitive systems for analysing proteins/DNA
  - Functional films, surface coatings and materials for rapid design, prototyping and production
  - Printing technologies for innovative surface structures

## 3.5 The Character and Impacts of the Projects

With the kind help of the institutes, we identified about two hundred k-funded projects and designed a short questionnaire aimed at the people who led the projects to map what was happening in them and their apparent outcomes. In many cases, individual project leaders were responsible for several projects. Rather than burden them with multiple questionnaires, we asked them only about one of their projects. As a result, we mailed[22] out 126 requests for people to complete questionnaires and obtained responses from the institutes as shown in Exhibit 13. Give the small numbers involved, we can say something about what kinds of activities individual institutes undertake, but it would be dangerous to assume that information about the proportions of different activities undertaken in individual projects is fully representative of individual institutes' use of k-funding overall. Exhibit 14 shows that we obtained a good cross-section of project sizes in the responses to our questions.

**Exhibit 13 Project Leader Responses by Institute**

| Institute | Responses | Institute | Responses |
|---|---|---|---|
| Acreo | 3 | MEFOS | 4 |
| Corrosion Institute | 4 | Santa Anna | 2 |
| IFP Research | 1 | SICS | 7 |
| IVF | 5 | STFI-Packforsk | 7 |
| KIMAB | 3 | YKI | 1 |
| | | **TOTAL** | **37** |

**Exhibit 14 Size of K-funded Projects in our Sample**

| Total Project Funding | Number of Projects |
|---|---|
| 1-250.000 | 8 |
| 250.000-1.000.000 | 9 |
| 1.000.000-5.000.000 | 9 |
| over 5.000.000 | 7 |
| **Total** | **33** |

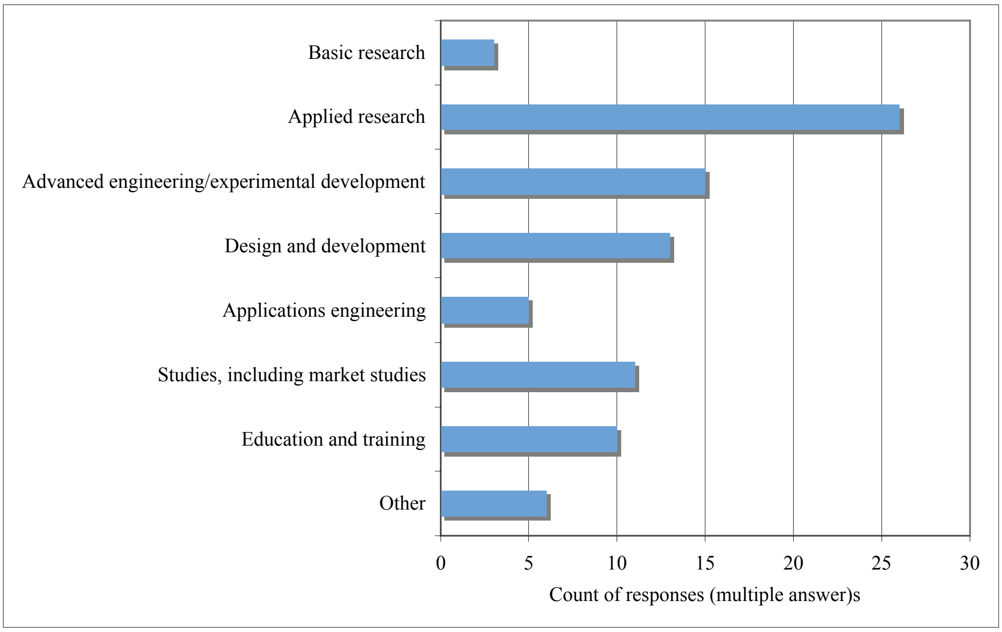
The projects cover a wide range of activities (Exhibit 15). We defined our terms rather carefully, basing the relevant definitions on the OECD Frascati manual[23] definitions, where relevant. Three project leaders claimed to be

[22] We used a web-based questionnaire hosted on the SurveyMonkey survey engine

[23] This is the manual used for collecting the OECD international R&D statistics. It focuses on the first three categories shown in Exhibit

doing basic research, but most of the work was in applied research and in development.

**Exhibit 15 Nature of Work Done in the Projects**

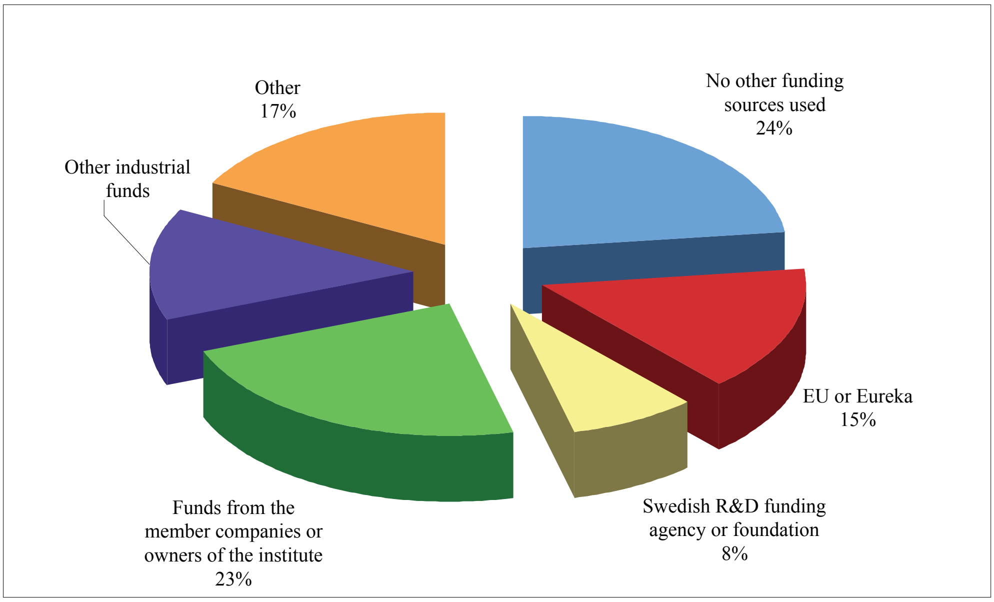



*n = 37*

Advanced engineering is the process of removing uncertainties in a technology, so that it is possible to do product or process development in the absence of known uncertainties. There was little applications engineering – in the sense of applying ready-packaged technologies to new applications. This pattern confirms that the k-funds are being used for the intended kinds of activity: namely, making or acquiring new knowledge, understanding and codifying it so that it can be re-used as a basis for other activities within the institutes. It is interesting to note how many of the projects involved studies, education and training, suggesting that the k-funds are used not only for purely technical activities but also to integrate technology into the research institutes' overall business.

The responses from our questionnaire suggest the institutes make creative use of multiple funding sources to construct capability development projects. This is consistent with the idea of a 'project fallacy' in research: namely, the idea that the projects research performers actually do are not necessarily the same as the ones the sponsors think they are funding (Exhibit 16).

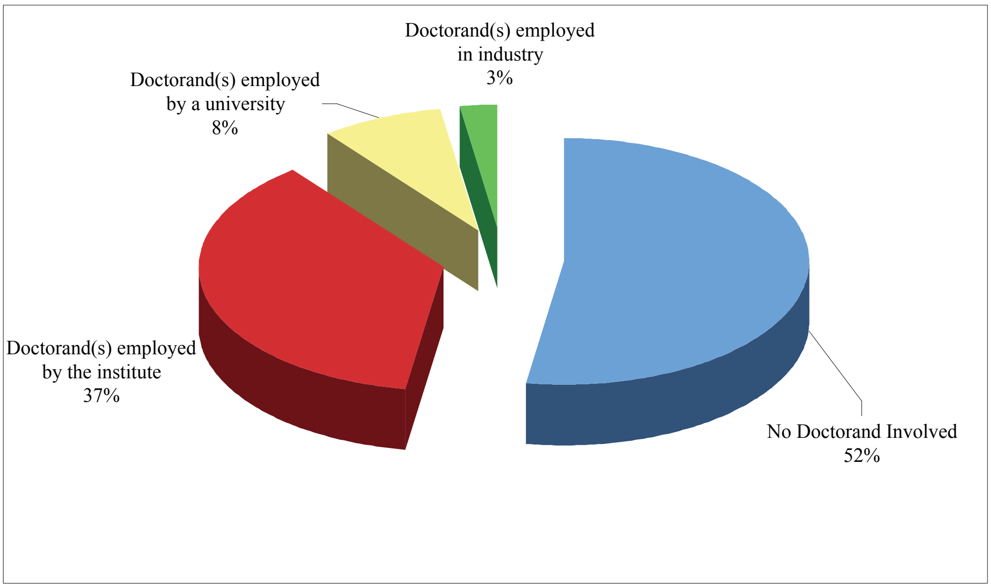
**Exhibit 16 Other Sources of Funding Used in K-funded projects**




*n = 37*

Half the projects surveyed involved doctorands, and a third of the projects involved doctorands employed by the institute itself (Exhibit 17). This confirms both that the institutes are to a considerable extent able to access academic knowledge and that academic linkage through doctorands is important to them, feeding directly into the process of renewing and extending the institutes' intellectual capital.

**Exhibit 17 Involvement of Doctorands in K-funded Projects**

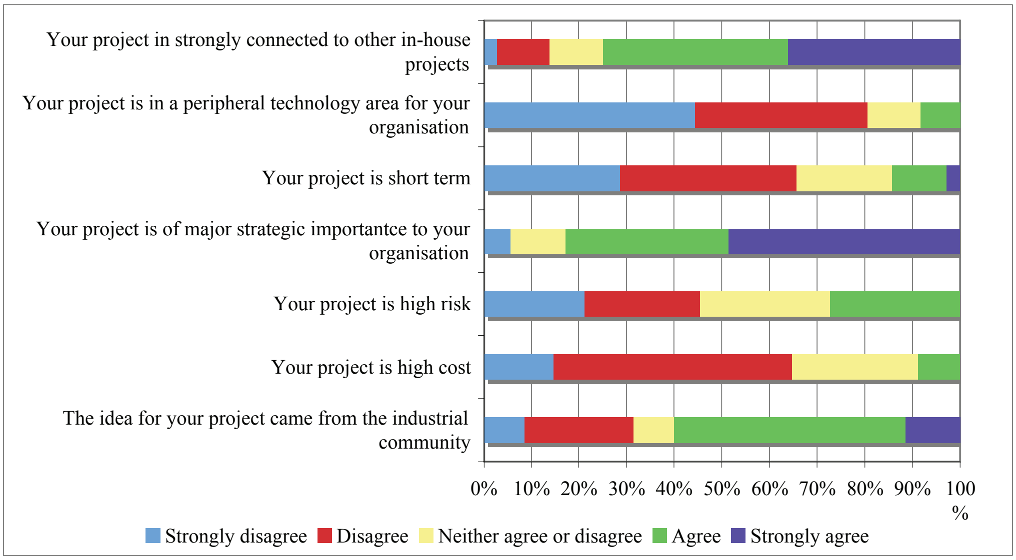



*n = 37*

Only about a fifth of the projects are done internally in the institute, without networking with others. Half network with Swedish universities and about the same number with companies. In this respect, the institutes' international reach is surprisingly good. The extent of networking with other institutes is also interesting, though it is no doubt influenced by the cooperation incentives provided in the 'structural' k-funding.

Exhibit 18 tells us that the institutes use k-funding to follow a strategy of related-product diversification. Projects are strongly connected to other in-house work and mostly central to the institutes' existing technology areas. They have medium-long term objectives and are of major strategic importance to the organisation. They are a mix of more and less risky projects, but large risks have been managed out of the process – presumably by careful selection and monitoring of projects. Projects are seen as small, and as prompted by ideas from the industrial community.

**Exhibit 18 Characteristics of K-funded Projects**

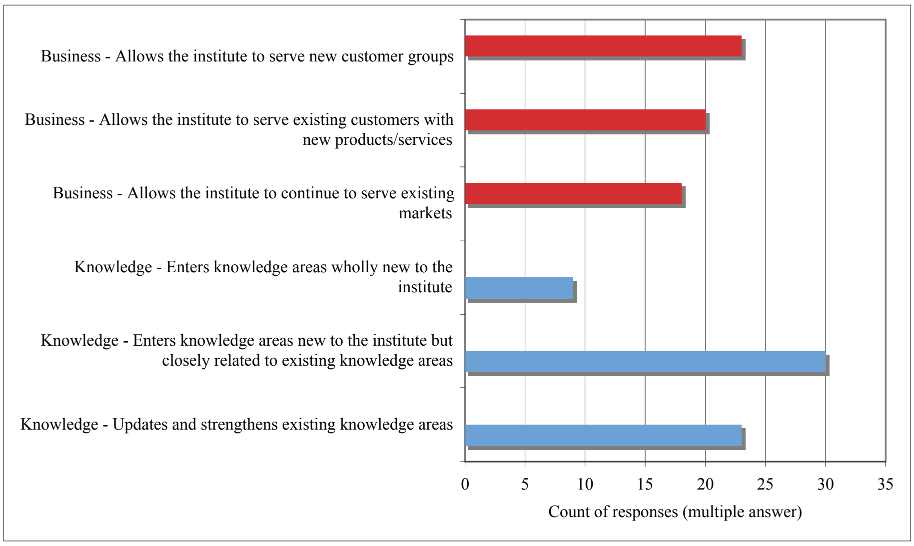



*n = 37*

We interpret these results as meaning that, given limited development resources, the institutes tend to choose k-projects somewhat conservatively and generally avoid big changes in direction. If more resources were available, we would expect to see more of the portfolio devoted to higher-risk projects and this would benefit the institutes by widening their strategic options. One uncertainty is whether the conservatism suggested by Exhibit 18 is solely caused by lack of resources or whether the memberships of many of the institutes also are a conservative influence.

Exhibit 19 tells us that the institutes were following a balance of objectives between reinforcing and updating their existing businesses and moving into new areas.

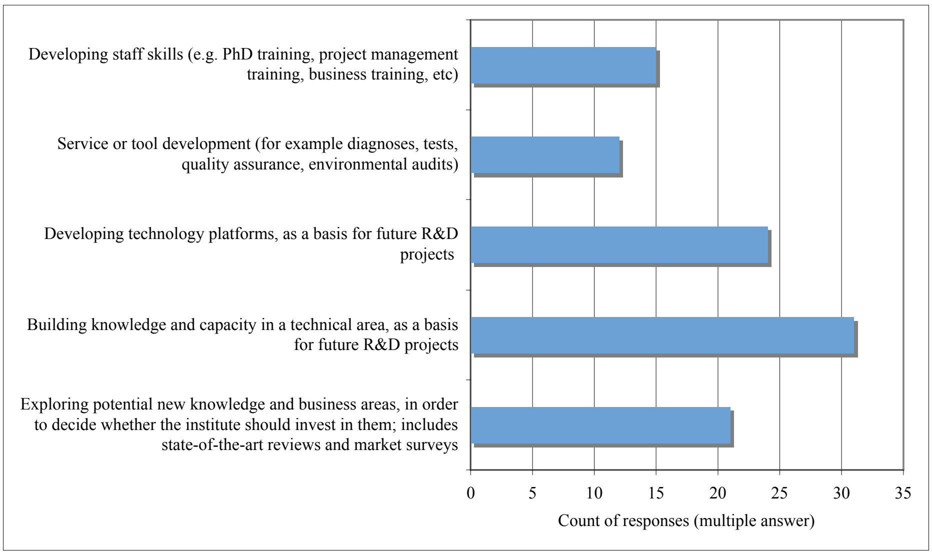
**Exhibit 19 Projects' Business Roles for the Institutes**




*n = 37*

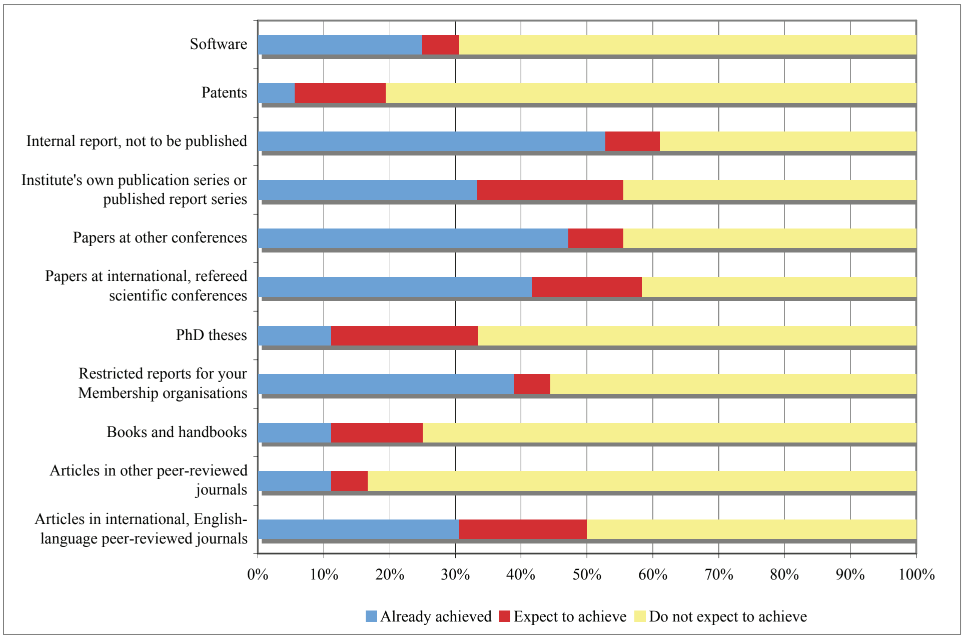
The roles of the projects for the institutes focused on building knowledge and capacity, and to a lesser extent on building specific technology platforms to support future institute development (Exhibit 20). Quite a number had an exploratory character – so that they were not only concerned with developing capabilities but also with assessing the relevance of those capabilities to the business mission of the institute.

**Exhibit 20 The Roles of the Projects for the Institutes**




*n = 37*

**Exhibit 21 Types of Publications Produced by K-funded projects**

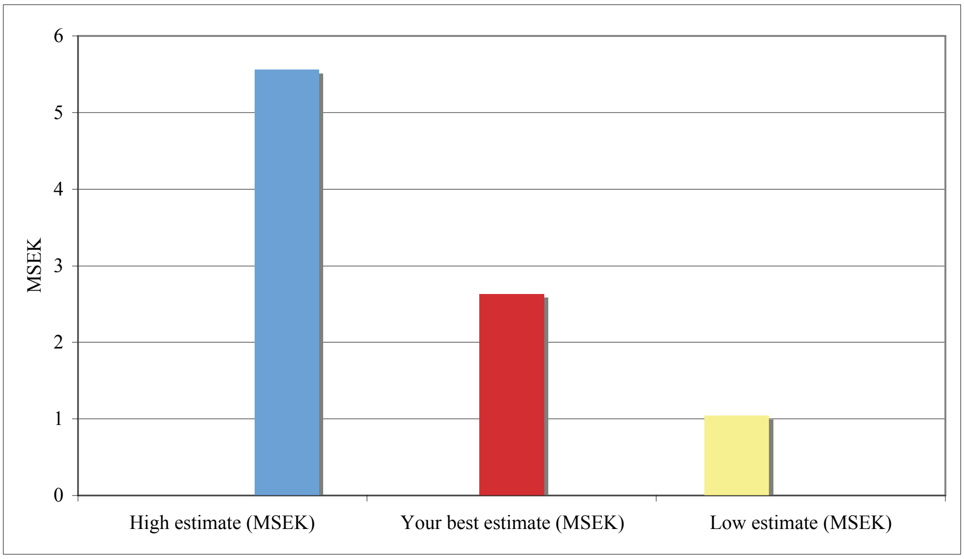



*n = 36*

Exhibit 21 indicates that the main channels of communication from the k-funded projects are via the institutes' habitual ways of communicating with their members, notably internal publications and conferences. The researchers clearly also place a high value on publishing in international peer reviewed journals, presumably because this both gives them individual status and serves as a way of advertising the quality of the work done at the institutes.

Some 92% of the respondents expected their projects to lead to increased revenues at the institute. Estimates of the value of projects were widely dispersed, as would be expected given their diversity. The following Exhibits show the types of economic benefits expected. In the questionnaire, we used a simple and arbitrary estimate of the likely income to the institute two years after project completion, so we take no account of complementary costs or of the likely life cycle of the new capability and the income associated with it. Project Leaders' revenue projections are of course by no means reliable as evidence of actual future benefits, but they do suggest there is considerable belief in the economic potential of the k-projects.

**Exhibit 22 Mean Estimates of Income Resulting from Project After 2 Years**




*n = 26*

# 4 Some International Comparators for the Swedish IRECO Institutes

This Chapter summarises and discusses information collected about seven foreign comparator institutes and institute systems

- SINTEF, Norway
- GTS, Denmark
- VTT, Finland
- TNO, Netherlands
- IMEC, Belgium
- Arsenal Research, representing the ARC system in Austria
- Fraunhofer Society, Germany

With seven observations, we have to careful about over-generalising – especially as there are some surprises in the way the institutes studied actually behave. The research institutes' activities are focusing increasingly on applied research and their skill and qualification levels are rising, necessitating closer links with universities and with doctoral training. They remain resolutely national while industry is globalising and this is a tension that will need to be resolved over time. The increased importance of markets means the institutes have to manage themselves in a more businesslike way. Large ones especially are going through organisational changes as they struggle both to be polytechnic and to be comprehensible to their customers.

All the comparator institutes share the three-stage innovation model of the Swedish institute system, but have a more generous core-funding basis. IRECO institutes' core funding is lower than that of all the comparators, when their income is adjusted for differences in the way different countries describe and handle such resources. While performance contracts are increasingly being used in connection with core funding, there is still scope for a lot of progress in more specifically defining and funding the various tasks of the institutes. Case studies of the individual institutes are provided in the Appendix.

## 4.1 Institute archetypes

Based on our study both of the Swedish and the non-Swedish institutes, we can see three archetypes. Some institutes conform to more than one

1 **Research associations**, which originally tackled common problems within one or more branches of industry and then became

institutionalised in the form of institutes. (The growth of Mekanförbundet, which eventually established IVF, is a good Swedish example.)  Some of these are still membership based

2 ‘**Technology push**’ institutes, sometimes set up in the more recent past, in order to promote industrial development more widely. SINTEF is an older example. Fraunhofer and IMEC are also in this category
3 **Services-based institutes**, generally focusing in their early years on measurement, testing and certification. Like the Swedish SP, these have moved ‘upstream’ into research. Arsenal Research is a clear example. VTT is a mixed case where a policy decision was taken to transform a services-focused institute into a technology push institute

Other factors also play a role in RTO development. In some cases, a defence mission was partly integrated into the RTOs. In others (notably ARC Seibersdorf) providing a home for nuclear energy research was an important factor.

It is worth recognising the diversity of the original missions of the institutes, because this affects what they do.

- SINTEF exists to use applied research to drive industrial development in a country where industry’s absorptive capacity was historically low but has now increased substantially. It was set up by university people and maintains a tight relation with the university system, especially in Trondheim
- GTS lives in an SME economy, where services such as measurement and certification are still a major part of industrial demand for knowledge services. The GTS institutes have their origins in a mixture of institutions set up by industrial organisations, research associations and testing establishments
- VTT is an interesting combination of both a ‘technology push’ research focus in the style of SINTEF and a more ‘test and services’ tradition, in an economy that has become very research-intensive of late but that has otherwise a lot more in common with resource-intensive Norway than with the comparatively advanced manufacturing economy of Sweden. VTT is also among the institutes that has a defence component
- TNO’s origins are in a number of small advisory organisations providing ‘industrial extension services’ and evolved from there into a ‘technology push’ institution whose capabilities also include defence
- IMEC is a very large but essentially free-standing ‘technology push’ institute, focusing on R&D rather than technical services
- Arsenal Research, part of the ARC group, is a combination of various test and measurement house that have been merged and that are moving into applied research. Despite its name (which derives from its former location in Vienna), it does not have a dedicated defence research activity

- Fraunhofer began with quite other purposes but was effectively adopted by the state and transformed into a strong national chain of 'technology push' institutes in a heavily industrialised country with a good university system and high industrial absorptive capacity. The strength of the TUV means there is no need for the Fraunhofer Society to be involved in testing services to any great extent and the strength of the other parts of the research system also means that Fraunhofer can focus more than other institutes on industrially relevant applied research

## 4.2 Drivers and trends

### Becoming more research-intensive

There is widespread agreement that many technologies are becoming increasingly scientific, with research making an important contribution to technological progress. The research may be fundamental (What is the molecular-level behaviour of catalytic materials?) or very applied (How do you build a computer simulation of something?) but the institutional implication is that the old 'three-hump model' of universities doing fundamental research, institutes doing applied research and handing results over to industry to put to use no longer works – if, indeed, it ever did. The division of labour between these classes of R&D performer is not clear; their activities need to overlap; and therefore their interrelationships need to be tight.

An important consistency among the RTOs' histories is that their customers grow increasingly sophisticated over time as industrial development proceeds, as production becomes more technology-intensive and as people throughout society become more involved with knowledge production through the 'massification' of education that Gibbons et al[24] say is one of the reasons for the growth of Mode 2 knowledge production: namely production outside the traditional university disciplines framework, driven by problems rather than theory and typically involving a range of different types of actor. The process of development therefore requires that industrially orientated RTOs increasingly move towards more demanding research, as some of their services become more commonplace and can be delivered by the private sector without subsidy.

There is a clear convergence among the institutes on the idea that the nature of the research they could and should be doing is Mode 2. SINTEF expressed this best via the Gibbons et al description of "Problems solved in the context of applications". Even the institutes with roots in testing are

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[24] Michael Gibbons, Camilla Limoges, Helga Nowotny, Schwartzman, S., Scott P. and Trow, M., *The New Production of Knowledge*, London: Sage, 1994

moving this way. This tends to confirm the general diagnosis that the 'three-hump model' of knowledge development and application is dead. It implies a need for a much closer symbiosis between institutes and universities, and therefore to the need for SINTEF and Fraunhofer styles of interaction.

In practice, the institutes are responding to this by increasing their overlap with universities. This is partly done by involving PhD students in the work of the institutes, especially in areas of applied research (sometimes even somewhat fundamental research), helping the institutes develop and renew capabilities. At the same time, quite a number of institute staff are doing PhD studies as part of, or alongside, their normal work in the institutes. In this way, and through recruitment, the institutes are tending to raise the level of qualifications of their staff so that they are more PhD-intensive. This is more important in research-focused institutes than in those that provide a large amount of technical services or that deal with lower-capability firms. Some 29% of SINTEF staff hold PhDs, compared with about 30% in the Fraunhofer Society[25], 31% in the Swedish IRECO institutes, 15% in VTT and 8% in the GTS institutes. The trend towards PhD-intensity appears to be accelerated by reductions in the number of support staff employed.

### Globalisation

All the institutes talked about globalisation as a driver, but none was really doing very much about it. Globalisation means that the demand pattern is changing; major customers of the institutes operate internationally and some even globally, but the institutes are not following suit. Despite some talk on the subject a few years ago, none of those we studied had a serious internationalisation strategy. The one clear case of internationalisation – TNO's purchase of 10% of Joanneum Research, the remainder of which is owned by the Austrian region of Styria – is apparently not part of a larger strategy. A few offices have been set up abroad, but the behaviour looks more stochastic than strategic. For example, Fraunhofer's small presence in Sweden (on the Chalmers campus) is an initiative by an individual Fraunhofer institute, and does not represent a policy of Fraunhofer as a whole. In the current situation, where institutes are funded by individual countries (or sub-sets of countries, like regions or branches of industry) there is little external incentive for internationalisation, even if – viewing individual institutes as if they were businesses – it would in many cases make commercial sense to do so. Indeed, this is clear from the cases of privatised RTOs like Qinetiq and PERA in the UK, whose transformation from subsidised RTOs into commercial Contract Research Organisations

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[25] Sverker Sörlin, *En ny institutssektor: En analys av industriforskningsinstitutens villkor och framtid i ett närings- och innovationspolitiskt perspektiv*, report to the Industry Ministry, Stockholm: Royal Institute of Technology (KTH), 20 June 2006

(CROs) has both freed and encouraged them to set up multiple offices abroad.

This situation may change in the future. Leijten argues[26] that internationalisation is becoming a key need for RTOs in the 21st Century, even if the extent to which this is to be done via institutional expansion or by networking in future is unclear. The example of IMEC shows that there can be large local benefits if an institute acquires an internationally strong position, with the institute sucking in research employment, capabilities and knowledge. It has for quite some time been clear that there could be advantages to improved cooperation, division of labour and perhaps also rationalisation among some of the institutes in the Nordic area[27]. Soete points out[28] that there is a huge gap between the concentrations of research and educational capability in the USA and their fragmented equivalents in Europe and argues that present policies are so incremental that they have little chance of achieving the desired restructuring needed to generate a system with the scale and clout of the USA. If the idea of a European Research Area[29] is to become a reality, then research resources will need to be much more concentrated. Now that EU research policy has shifted to make increasing use of 'variable geometry' and the Commission is taking its mandate to 'structure' the ERA more seriously, incentives for cross-border restructuring may well appear, at least within Europe.

### Long run increase in the importance of markets

Over a very long period, the institutes have tended to derive a growing proportion of their income from R&D markets (competing for public as well as private work). As a result of the growing need to be 'businesslike' in accessing these markets and in managing the institute, all the institutes were trying further to improve their business processes and their staff's awareness and understanding of business as well as technology. This included attempts to make people 'IPR-aware' in a way they have not previously been by improving and documenting laboratory practice and more deliberately looking for commercialisation opportunities that would benefit the institute, and not only its customers.

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[26] Jos Leijten, 'The Future of RTOs in the European Research Area', Contribution to the DG Research expert group on the future of key actors in the European Research Area, Delft: TNO, 2005

[27] Erik Arnold, Annelie Eriksson, Sven Faugert and Tommy Jansson, *Building Nordic Strength Through More Open Funding: The Next Step in NORIA*, Norden som global vinderregion, Studie nr 3, Copenhagen: Nordic Council of Ministers, 2006

[28] Luc Soete, *Activating Knowledge*, Discussion paper produced for the UK presidency of the EU, October 2005 (mimeo)

[29] *Towards a European Research Area*, Communication from the Commission to the Council, COM(6), January 2006

### Commercialisation

Almost all the institutes were engaging in the '3rd task' of commercialisation, but in a way that was rather unreflective. Since the universities are developing commercialisation mechanisms, so the institutes are following, but the arguments for doing so are not much discussed. At a certain level these activities make sense. The institute directors are running quasi-businesses, so anything that makes money is interesting. The implications for society are less clear, since protecting spinouts and developing patent portfolios also mean that institutes may find their interests in conflict with those of their customers. We found SINTEF's clarity about having a social and not just a commercial role very refreshing – but it is not evident that many of the institutes has fully thought through the implications of these activities for that social role.

### Organisation and Scale

The institutes we looked at all had, or sought, scale. Most believed that they needed to be polytechnic in order to service wide-ranging customer needs, and to be big enough in each specialisation to be attractive to customers and be visible internationally. They were reducing the number of divisions or departments and tending towards matrix structures to achieve this. Some were adding interface functions – guides or gatekeepers to help potential customers find their way into the largest of the institute groups. Institute management was generally organising formal customer satisfaction surveys. In some cases, increased central functions appeared to be reducing the agility of the institute. Organisationally, a lot spoke for 'thin' centralisation in the style of SINTEF, where the centre has enough power to add value but where the life and spirit of the organisation is still rather decentralised.

We were a little disappointed at how unreflective the institutes tended to be about their own role. They did little or no measurement or classification of their tasks, perhaps because they saw themselves as 'running businesses' rather than serving market segments or meeting specific social needs. They did little conscious market segmentation. Most believed that it was important to maintain much of the responsibility for marketing at the researcher and project leader level, even if aspects of central marketing were being strengthened.

### Lock-ins

There appeared to be some important lock-ins among the institutes. Fraunhofer's strongly decentralised power structure makes it difficult to devise and implement strategy. This may, for example, help explain the lack of a real international strategy despite the huge potential of the Fraunhofer brand. Links with universities were obviously useful, but there was little sense that the structure of these links was changing fast, in response to changing circumstances and opportunities. Above all, national boundaries and national funding represent a major source of lock-in.

## 4.3 Business model

The institutes all had a common three-stage mental model of their business. This involved a first stage of using subsidy (and sometimes other resources) to generate new ‘platform’ technologies and capabilities. In a second, often pre-competitive stage, these were further developed and explored in partnership with industry. Often the second stage involved working with groups of companies. In a third stage, when the technology was mature enough to be put into specific applications, the institute would work bilaterally with firms, providing development, applications engineering, consultancy or other services. Through this three-stage process, the amount of private funding rose as a proportion of income, so that the role of the public money is to initiate the capabilities that the institute subsequently exploits.

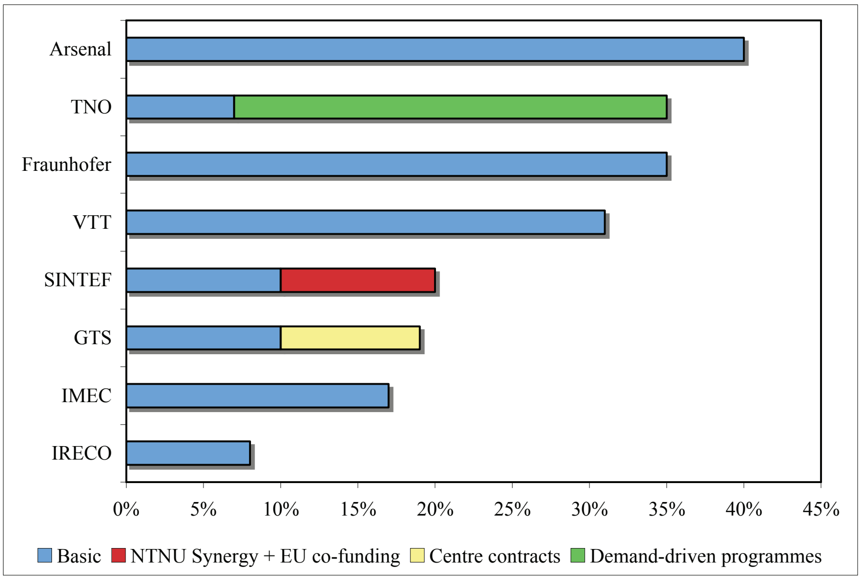
## 4.4 Issues

### Financing

None of the institutes was able to argue convincingly for getting a particular level of core funding. All saw funding in the 30-50% range as desirable.

In Exhibit , we compare the apparent core funding of the institutes studied. We have made some simple corrections to make the numbers more compatible. In the TNO bar, we distinguish between the 7% basic funding and the 28% demand-driven core funding provided to the organisation. In the case of SINTEF, we have estimated the value of the doctorands placed at the institute by the universities plus the money RCN provides to co-fund SINTEF participation in EU Framework projects. We have added innovation contracts income to the GTS funding, since this is intended to generate new capabilities in the institutes. The latter two adjustments are, of course, approximate but they do help us understand SINTEF and GTS core funding on something closer to a ‘like for like’ basis with the Swedish institutes. Even with these adjustments, there remains considerable variation in the amount of core funding provided. However, they do make it clearer that the lower level of core funding of the Swedish institutes is an outlier – quite different from the levels of such funding seen elsewhere.

**Exhibit 23 Institutes' Core Funding, 2005**




***Source:*** *Institutes; Technopolis estimates*

Core funding is in principle a 'lever' that helps decide what tasks institutes perform. The more core funding an institute has, the better equipped it is to tackle market failures and to develop new capabilities that cannot be created with private sector economics. Basic research institutes, like those of the Max Planck Society, operate with high levels of core funding: over 80%, in the case of Max Planck. Within the range of core funding shown in Exhibit 23, it is clear that the Fraunhofer Society can devote more effort to applied research that the les well funded GTS system. However, the range of behaviours of the institutes we studied is too variable for a general rule of 'the more core funding the more fundamental the research' to apply. It seems, rather, that high core funding **permits** fairly generic research activities to be done but does not **ensure** that they will be. Walwyn and Scholes[30] have recently provided statistical evidence that failure to manage the core grant has allowed the South African CSIR institute to use it for organisational slack and to cross-subsidise external contracts. This reinforces anecdotes and experience of cross subsidy from elsewhere. Also, as SINTEF clearly shows, there are more ways to get capabilities than through explicit core funding: the synergy with NTNU is a massive contributor to SINTEF's capabilities. Since the Research Council of Norway co-funds EU projects separately, SINTEF does not (unlike some others) need core funding for this purpose.

[30] D Walwyn and RJ Scholes, 'The impact of a mixed income model on the South African CSIR: A recipe for success or disaster? *South African Journal of Science*, No 102, 2006

Core funding is not the only source of financial and institutional strength. Having a cushion of their own capital is an important support for institute directors and allows them to manage the institutes' strategy better. The pattern is variable within GTS. Other institutes did appear to have such protection (even if the idea of 'Eigenkapital' is foreign to some of them). This is another important difference with at least some of the Swedish institutes, which lack such a cushion and the corresponding strategic flexibility.

We were also a bit surprised that there was little consideration given to differentiating public funding for different institute tasks. The idea of the institute as a single 'business' was dominant. However, if we crudely distinguish between the following tasks (most performed in varying degrees by most of the institutes considered)

- Linking the wider research community to social needs, so as to make society's investment in research overall more productive
- Taking research and development related risks on behalf of society, through applied research
- Measurement, testing, certification
- Information and consulting services
- SME support services

it is not at all clear that there is a uniform economic case for funding them. It may well be more reasonable for the state to take a segmented approach and to buy whatever amount of each that it believes the innovation system requires, as and where there are no market solutions to providing the tasks. Generally, however, even where there are explicit performance contracts with the institutes, they specify some package of indicators as evidence of delivery, rather than clarifying the individual acts of performance that are required. There was some measure of agreement among the institutes that providing support for comparatively low-capability SMEs was not central to the institutes' business model. It therefore needed to be separately resourced from the mainstream of what they do.

It was striking how rooted the institutes still were in the manufacturing economy and how little of the 'new economy' and services was visible, with GTS - the most commercially dependent institute system examined - as a possible exception. Some of the institutes had social science capabilities at their disposal. VTT and Fraunhofer tended to treat these separately from the 'line' engineering capabilities, while SINTEF had integrated them into its main business.

The institutes we studied were almost entirely state owned. The exception is part of ARC (Seibersdorf), which declined to take part in our study but which is regarded by others in the group as having been locked into an out-dated structure as a result of industry owning a significant proportion of its shares.

# 5 The Role of the Institutes in the Swedish Innovation System

This Chapter is based on work with the six 'focus' institutes selected for deeper study: ACREO, IVF, SIK, The Swedish Foundry Association and SP. It also looks at three examples of what universities do when they try to work in ways similar to the institutes, in pursuit of the 'third task'.

Something over half of institutes' projects are done with and for networks of firms and other research-performing institutions. These tend to be the larger projects, so the institutes play an important role in developing and communicating knowledge within innovation systems. In up to a third of the cases, cooperations involve entities abroad.

The institutes do two clusters of activities. There is one cluster associated with product and process development. This consists of applied research, advanced engineering,[31] design and development and applications engineering. The second comprises a spectrum of technical services from education and training to prototype production, of which the most frequent is measurement, testing and certification. The first cluster tends to take customers 'one step beyond' their existing knowledge while the second cluster provides complementary assets, in which it would be irrational for the firms themselves to invest.

Institutes' generally work close to their customers' 'core' technologies, especially in the first cluster. Services are less strongly connected to companies' core technologies. We had wondered whether institutes sometimes helped companies enter wholly new technology areas, but this seems not often to be the case. Companies use other mechanisms in order to do that. Institutes are about deepening and strengthening, not radical change.

Institutes' skills and resources are radically different from those of universities. Institutes have practical understanding of industrial processes and norms, strong project management and cost control and a disciplined IPR regime that is friendly to their customers. Unlike universities, they do not generally try to capture and exploit IPR that is generated with or for industry. They are not tied to postgraduates as a source of research labour so they can be flexible about the subjects, length and difficulty of the projects they undertake.

[31] In OECD terminology, this is called 'experimental development'

Some of the university people we interviewed felt that the institutes did not normally do 'proper' research and that it would be better if the corresponding resources were given to the universities. It is clear from our study that the institutes do research and other activities that are 'proper' in their industrial context, that this work is useful precisely because it is based on skills the universities do not have and that it delivers socio-economic value that the universities cannot provide. The academic idea that university work can be substituted for what the institutes do is founded in a linear model that does not describe the way innovation actually works and based on an arrogance about institute research that has its basis in ignorance of industrial reality.

Our surveys tend to confirm the 3-step innovation model generally used by institutes, moving from grant-funded competence building and proof of concept through more open pre-competitive research in partnerships with industry to more customer-specific work (often bilateral) on applying technology. More technologically sophisticated firms become involved at the second stage while less sophisticated ones may have to wait until the third stage. In either case, interaction with the institute reduces innovation risk.

## 5.1 The customer perspective

We spoke to a total of 15 people from five of the focus institutes, who had been identified by the institutes as being customers. (One did not provide any customer contacts.) There was wide but systematic variation in the qualification level of the customers. One third of these people, all of whom were customers either of SIK or YKI, had doctorates. Two more people held licentiates (SIK and SvGj customers).

There was variation in how customer companies decided to make use of the institutes. The SMEs decided on a rather ad hoc basis, buying projects as and when needed. Foreign-owned multinationals tended to have a central decision-making process for R&D, but it was possible to make use of the resulting R&D budgets to some degree. Decision-making appeared less centralised in the Swedish-owned multinationals, so that Swedish managers there had greater freedom to use institute services. Almost all the companies took decisions about small projects or assignments at a lower level than large projects. Only 2 of the 11 customers we interviewed in large companies said that they had a clear and inflexible budget for external R&D services. In most cases, spend was driven directly by needs rather than by a budget and could therefore vary over time.

We can see three relatively distinct groups of companies within our interview sample.

- 'Heavy hitters' with internal R&D budgets in at least the tens of millions of kronor and external research spending in the range 1-25 MSEK. Some of them set explicit budgets for external research spending, especially at the universities, where they may sponsor PhD candidates. The actual balance of spending between institutes and universities varies greatly. In some cases 75-80% of the spending is at universities while in other cases the ratio is the other way about. The biggest spender on external research spent his entire external budget at institutes. University spending tended to be associated with developing human resources and therefore to be more predictable than spending at research institutes, which was more driven my shorter-term technical needs. Almost all our interviewees who held PhDs worked for these firms.
- 'Large producers' – companies, including foreign multinationals, which performed limited R&D in Sweden, either because they have R&D facilities abroad or because their activities are not R&D-intensive. Their external spend was much more modest – typically in the range 300KSEK to 1.25 MSEK. They work to some degree with research institutes but have more limited contact with universities. Their university contracts involve small sums of money – generally too little to sponsor PhD students.
- 'Competent SMEs' with some degree of technical capability, though not someone with a doctorate. These firms devoted external R&D resources exclusively to institutes, spending in the range 2-300 KSEK

The categories to which big companies belong can vary between Strategic Business Units (SBUs). One part of a large, multidivisional firm may be a 'heavy hitter' while another part can behave as a 'large producer'. In other cases, where large firms follow a strategy of operating in small SBUs (Racal and ABB are examples of companies that have tried to work in this way, though neither is present in our sample here), some SBUs may operate as 'competent SMEs'. Equally, it is important to reconise that, while size matters, it is not everything: technology-intensive small firms can at times behave as heavy hitters.

Whether multinationals have R&D in Sweden or not makes a big difference to the way they interact with the institutes. One company with its headquarters in Germany[32] questioned the value of paying it membership fee to a Swedish institute, because the extreme centralisation of research in the company meant the Swedish part of the operation had little freedom to buy external research.

[32] There is at least anecdotal evidence from our earlier work in Ireland and elsewhere that German multinationals are prone to extreme centralisations of R&D to Germany, compared with the more open attitude of the US multinationals, which increasingly allocate R&D resources – like production investments – competitively among their various national operations

Some of the companies were able to be very clear about the different ways in which they used institutes and universities. For example

- One large Swedish company used SIK in projects that involved sensory testing, storage and shelf life, developing process technology and packaging, while it turned to the Universities in Uppsala and Gothenberg, Karolinska Institute and the University of Maastricht in relation to nutrition research
- We talked with one division of another large Swedish company with substantial internal R&D resources. It sponsored 5 PhD students and participated in other R&D programmes with universities. Creating a pool of people from which to recruit was one important motivation for maintaining these university relationships. It went to institutes when it had a clearly-defined research question, it needed to achieve specific technological goals or when confidentiality was important
- A third company had worked for many years with SP on matters of testing and characterisation, but turned to LTH to understand the fundamental physics of crack development and propagation
- A fourth recognised that, while there was a division of labour between SFA and its partner Centre for Innovation in Casting at the University of Jönköping, there were also areas of overlap and therefore worked with both in partnership

One person we spoke to saw university-based competence centres (in the sense of the VINN Excellence programme) as a distinct category. They were sources of leading-edge research in areas where it was useful to network with other industrial companies. For some of the customers, university or scientific knowledge was too remote to access. The institutes provided a very useful bridge that allowed them to benefit from scientific knowledge that they could not themselves have exploited directly. This knowledge might reside in universities, foreign institutes or in the scientific literature.

The customers were involved in projects that went 'one step beyond' their own capabilities. They did not have the ability to do the projects themselves, so they were not taking 'make or buy' decisions when deciding to work with institutes or universities. At lower levels of complexity (such as measuring, testing evaluating and selecting materials, etc), this meant that the institutes let them access resources and techniques not available in house. In connection with more research-related projects, the companies were usually reaching outside their organisation in order to obtain needed scientific or technological understanding. Institutes were able to embody this in processes and products, according to a fairly well defined timetable. Universities were able to tackle more fundamental questions but – in the nature of research (and based on the way the universities operate) – such results were not likely to appear in a timely way.

Taking all the discussions together, our interviewees associated the following ideas with the institutes and universities respectively.

**Exhibit 24 Ideas Interviewees Associated with Institutes and Universities**

| Research Institutes | Universities |
|---|---|
| Resources | Developing human resources, especially PhDs |
| Competence | Basic and precompetitive research |
| IPR handled professionally | No timetable |
| Confidentiality | Difficult to steer or predict outcomes |
| Used to working with industry | Poorly equipped, compared to the institutes |
| Project management routines in place | May be opportunities to get additional state funding to carry on the project |
| Timeliness (mostly) | |
| Can address focused research questions | |
| Close to applications and products | |
| Understand real industrial processes | |
| Understand industrial customer needs | |
| Less focus on publications than universities | **Note**: In the special case of competence centres, access to academic and industrial networks were also mentioned |
| A 'bridge' to scientific knowledge | |
| Bring in university partners where that is useful | |
| Proximity an advantage – especially when significant R&D projects are done together with an institute | |

Many of our interviewees were enthusiastic about multi-firm projects with the institutes. These tended to produce useful knowledge and could be quite effective, especially when many of the firms were actively involved in the projects. In many cases, the speed and critical mass of such work far outweighed any IPR benefits the company could have enjoyed, if it had funded the work alone. These types of project handled rather generic questions – for example, how foundries can re-use sand in sand casting.

Some of the big customers had experience of foreign as well as Swedish institutes. (The foreign institute most commonly mentioned was Fraunhofer, though some companies also had experience of US and UK institutes.) There appeared to be some cultural differences as well as geographical ones between Swedish and other institutes. Customers saw the Swedish institutes as well organised (for example, good at meeting deadlines) and better attuned to customer needs than the foreign institutes, in addition to being nearer to hand and therefore more accessible. Some foreign institutes could be very formal in their customer relations, compared with Swedish institutes. The main reason for going to foreign institutes was their greater size and their greater knowledge and capabilities in certain specialist areas. SFA was good at making connections with foreign institutes in order to access specialist knowledge. Small customers felt that direct contacts with foreign institutes were beyond their grasp. They effectively had no choice but to work with the Swedish ones.

Different institutes did different things with their customers. Unsurprisingly, despite SP's more research-intensive strategy in recent years, its customers also bought testing and certification services. YKI's customers were more science-orientated, and so on. Correspondingly, there was an association between the research content of assignments and the qualification level of the people doing the buying. This is exactly what we would expect to be the case, based on the literature about 'absorptive capacity'.[33]

Measurement, testing and certification services had been important for some of the smaller companies in establishing relations with the institutes. One came to SIK for advice on the changes needed to adapt to Sweden's entry into the EU. Since then, many personal relationships have developed with SIK staff, making it much easier to buy more projects there. About a third of the people we talked with had relationships with institutes that stretched back more than a decade. They were comfortable with picking up the phone and talking to their friends at the institute. According to need, these contacts resulted in advice and suggestions or led to a paid assignment for the institute. Companies we interviewed did not generally have similar contacts with universities, but there is evidence in the customer questionnaire that others have relationships with universities that are also informal and flexible.

Companies' own active involvement in some projects was a condition for success. This was certainly the case for substantive research projects, where it was necessary to have an in-company project or activity that could interact with the institute research and make use of its results. Some consulting projects also needed a lot of customer involvement in order to implement the results. Other projects, such as testing or information services, required little effort on the part of the customer. However, where relevant, some customers were keen for the institutes to be clear about the need for active customer involvement.

More generally, customers felt that some of the institutes should be clearer and more proactive in their marketing

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[33] Wesley M Cohen and Daniel A Levinthal, 'Absorptive capacity: a new perspective on learning and innovation,' *Administrative Science Quarterly*, Vol 35 (1), March 1990, pp128-152

- IFP and YKI open days were cited as good practice
- Institutes should follow up assignments: making contact after the event to find out whether results were being used and therefore to be able to generate follow-on business
- A small firm said that it was important for the institute to understand subsidy opportunities, as it was difficult to finance the institute's work out of its own cash flow
- One of the (foreign-owned) 'large producers' said it was essential for the institute to market its capabilities to its parent company in Germany, otherwise it would be difficult ever to use the Swedish institute to a large extent – even in Sweden

Most institutes were praised for their close industrial interaction and this was an important source of ideas for both institutes and customers, but some of them were felt to lack long-term strategy or a road map.

## 5.2 Institute Customer Survey

Our project design called for identifying 50 projects for each of the six focus institutes and asking both the project leaders and the customers to complete questionnaires about the project. For various reasons, the institutes were not always able to supply this number of contacts, and it was necessary to disconnect the identities of the customers from the names of the projects in order to meet the institutes' conditions for confidentiality. For the customer part of the survey we were therefore able to contact the numbers of customers shown in Exhibit 25.

**Exhibit 25 Customer Survey and Response Rates**

| Institute | Mailed | Responded | Response rate |
|---|---|---|---|
| Acreo | 27 | 8 | 30% |
| IVF | 35 | 9 | 26% |
| SIK | 43 | 7 | 16% |
| SP | 43 | 12 | 28% |
| Sv Gjut | 9 | 2 | 22% |
| YKI | 11 | 4 | 36% |
| **Total** | **168** | **42** | **25%** |

Some 20% of the respondents worked in owner-managed companies, so the bulk of the response comes from relatively established firms with professional management while there is an important minority of family and start-up firms. Half the firms[34] employed 250 or more people, while a third employed less than 50, so the sample suggested that the institutes'

[34] n = 34 for this question

customers well reflected the famous 'hourglass' structure of Swedish industry.

Just over half the customers described their company as part of a 'concern'. The same proportion expected that their number of employees would grow over the coming two years, while another third planned for unchanged employment, so most of the respondents regarded their company's business positions as strong. The companies were also quite strong in technology. Some 80% said they had an R&D department at the location to which we sent our questionnaire. One third of SP's customers did not have an R&D department. Two-thirds (65%) of the customers employed at least one person with a scientific or technological PhD on site.

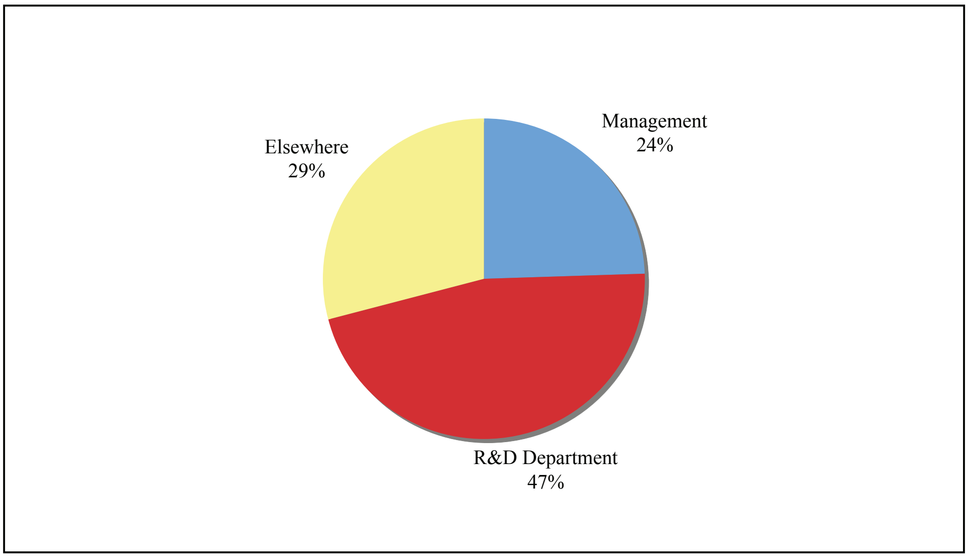
In general, companies are interested in institutes in order to access 'complementary assets' in the form of knowledge and equipment. Generally, institutes help them go 'one step beyond' what they could do themselves. Just as companies do R&D and other technical activities in order to solve problems on the way to innovation, so they go to institutes for help when they encounter technical problems they cannot themselves handle. These may involve sophisticated questions to do with product and process development. They can also involve more straightforward matters of testing and certification.

The interface between companies and institutes generally comprises the R&D department or some other technical function. Especially in smaller firms, where there is not always a clear division of labour between commercial and technical management, it may also be managers. This means that it is very difficult for the Swedish knowledge infrastructure to serve multinational companies, unless they have some sort of technical function in Sweden. Sometimes it is necessary to have links with headquarters of technical functions abroad in order to access the Swedish part of the company.

It is important to recognise that the company 'interface' with the institutes is made up of people. The qualification level and competence of the people at the company interface determines the type and difficulty of the problems with which they seek help. Thus, SP's customers – many of whom want testing-related services – are on average less qualified than those of, say, ACREO, which provides few testing services. In most cases, however, the socio-economic function of the institute is the same: namely, to provide missing bits of capability and therefore to reduce the risks of innovation. In practice, companies use the results of institute work as a basis for making decisions and in product and process innovations. Surprisingly often (30% of cases, in our survey of customers) results are also published.

Different institutes' customers came from different parts of their organisations (Exhibit 26). SIK's customers focus on R&D. Two thirds of SP's are outside either R&D or management. ACREO and IVF's customers split evenly between R&D and general management.

**Exhibit 26 Location of Project Customers in their Companies**




*N = 41*

Half of the customers had a technical master's degree and a further quarter had research training (5% licentiate and 20% PhD). Acreo's customers were especially highly qualified while SP's were at the other end of the spectrum.

The bulk of the projects were done in various kinds of networks. About half involved a university or another institute in some way and almost as many involved other companies. Almost half the respondents said their project involved some sort of cooperation outside Sweden.

Cooperation is strongly associated with the way projects are funded. All the customers who said their projects were in some way funded by Swedish or foreign research funders or by institute members were involved in networked projects. But even in the case of projects funded by the company or other industrial sources, networked projects were slightly in the majority. In this sense, institute projects promote innovation system linkages.

Exhibit 27 shows that the location of the customer for the project in the organisation influences the type of networking involved. The 'Other' category largely comprises technical functions outside formal R&D departments. People in technical functions are more likely to network with universities and other companies than managers.

**Exhibit 27 Cooperation Partner Categories broken down by Role of the Customer in the Company**

| | University | Other Research Institute | Company(ies) | N (100%) |
|---|---|---|---|---|
| | In Sweden | In Sweden | In Sweden | |
| **Company management** | 20% | 40% | 20% | 10 |
| **R&D department** | 47% | 37% | 37% | 19 |
| **Other** | 58% | 67% | 58% | 12 |
| **Total** | 46% | 49% | 41% | 41 |

30% of the projects were financed solely by the customer's company. Agencies and foundations contribute to one third of the projects while about the same proportion involves contributions from other companies. The 'Other' category displays considerable creativity, including Nordic funding, the European Space Agency, individual companies and agencies not normally associated with R&D funding.

Only 5 of 41 responding projects included an element of doctoral training, tending to confirm the importance of k-funding rather than routine projects as a source of new research and manpower for the institutes. Two customers reported that basic research was involved in their projects. The big peaks in institute activity, according to the customers, are where we would expect them to be: namely, in applied R&D; and in testing. Most of the testing projects, of course, are small compared with the R&D projects. The low number of projects reporting 'Information, advice' as an aspect of the work results from the question's focus on paid-for projects. The customer interviews made it clear that the institutes provide a lot of more informal advice **outside** the project context. As one would expect, projects supported by Swedish R&D funders were the most likely to contain elements of applied research, advanced engineering, design and development or to be studies. Member-funded projects were also more likely than most to involve applied research. Projects involving basic or applied research were more likely than others to lead to publications.

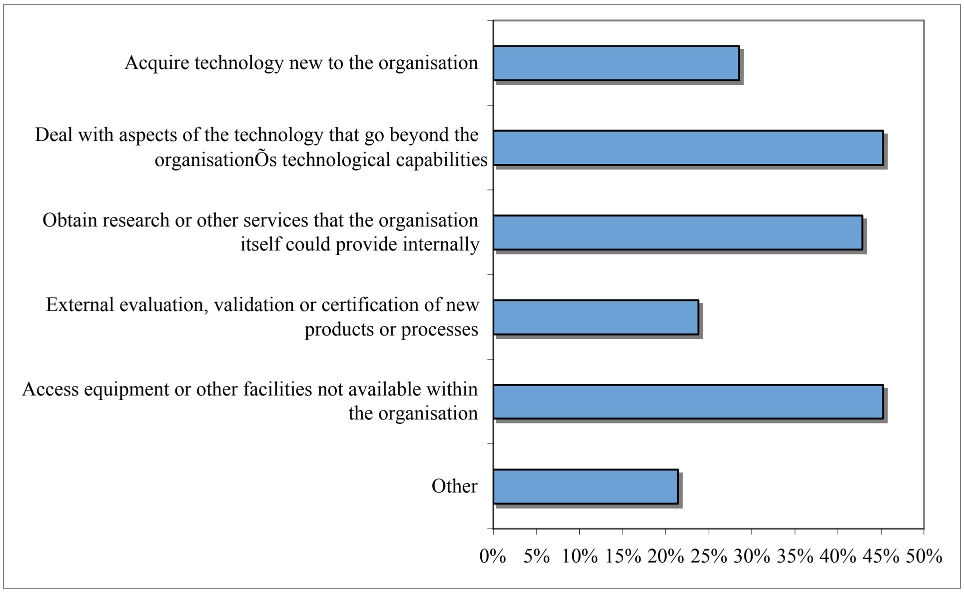
The projects were almost all close or very close to customers' core technologies. Those supported by Swedish R&D funders or members' funds were likely to be more central to company technologies than those funded by the companies themselves.

Exhibit 28 partly confirms the impression from the interviews that customers aim to move 'one step beyond' their existing capabilities via the institute projects, seeking new technologies, tackling aspects of technology that they do not currently master and accessing resources not normally available to them. Projects with these aims are especially likely to be supported by Swedish R&D funders. However, customers say that they could have done part or all of the project themselves in just over 40% of the cases, using existing resources. Much of the work of the institutes therefore is additional to, rather than displaces, company R&D. Where this is not the case, we assume that companies are likely to be peak lopping so that they do not need to expand their permanent development capabilities.

In 7 of the 10 cases where companies are looking for external evaluation or certification of new products and processes, the customer works in the company R&D department. While this is not the commonest use for the institutes, it seems therefore to be an important and highly qualified one.

For all the first three categories in Exhibit 28, projects were more likely than most to involve advanced engineering. Projects acquiring technology and dealing with aspects of technology going beyond the customer's existing capabilities were particularly likely to involve design and development and are especially unlikely to result in publications.

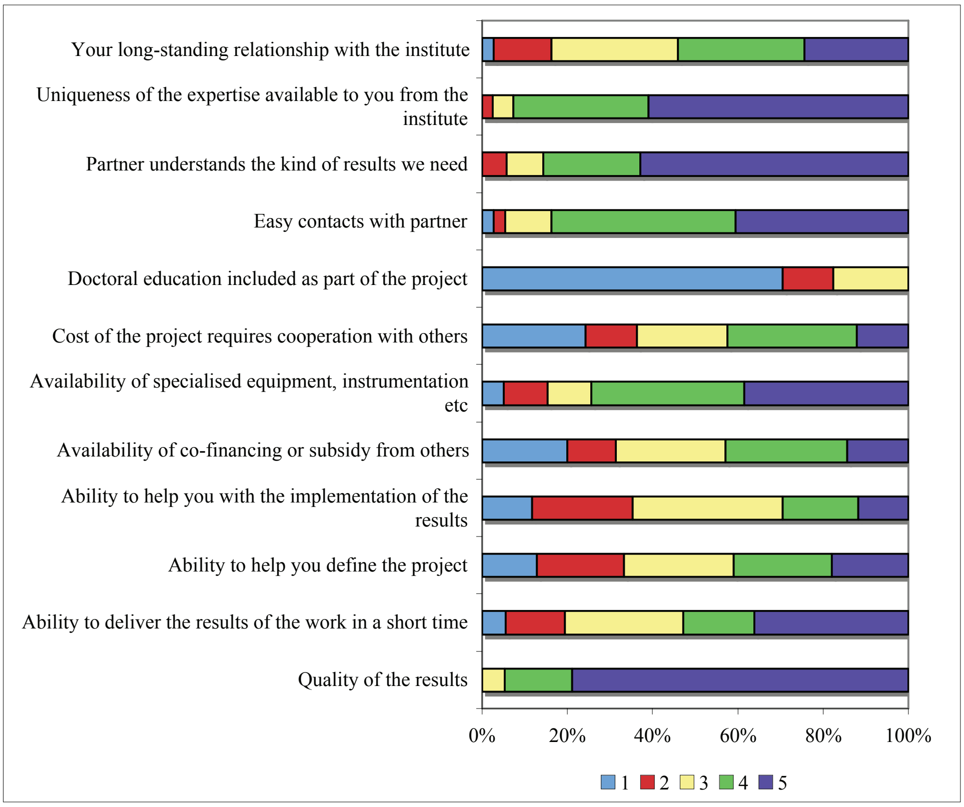
**Exhibit 28 Aims of the Customer (% of projects)**




*N = 42*

Exhibit 29 (which is in decreasing order of the average score awarded by the customers for each category) shows that the main drivers for using the institutes are the quality and uniqueness of their assets and their work, and the institutes' ability to understand customer needs, often in the context of long-standing relationships. Cost factors were said to be less important.

**Exhibit 29 Importance of Factors in deciding to Use a Research Institute (1 = low; 5 – high)**



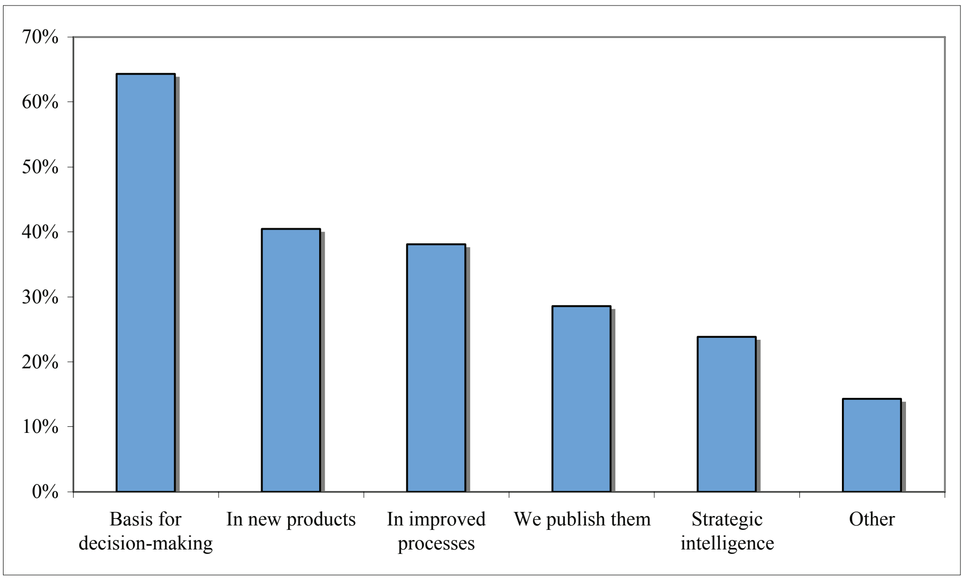

*N = 37 – 41*

Between 37 and 41 customers answered our questions about factors affecting the use of institutes. A smaller number – between 23 and 27 – answered the equivalent question about using universities. Given that partially different populations are answering these questions, the similarities of response are startling. The means of the responses are within 0.2 in all cases except for the importance of long-standing relationships and of doctoral education, where the mean for the universities is 0.4 higher than that for the institutes. This means, there is a modest population of firms for which doctoral education forms a basis for university relationships. Some university relationships are also very long standing. (We have encountered examples in a wide range of studies in Sweden.)

- People outside R&D departments tended to value the Knowledge Infrastructure's ability to help them define projects more than people inside R&D departments, who presumably felt more capable of doing this definition themselves
- Non-R&D personnel were more likely to see the Knowledge Infrastructure's capabilities as unique than those in R&D, who presumably have a better view of potential research suppliers and partners. R&D personnel were more likely to see university than institute capabilities as being unique

- Most respondents saw the institutes as being much better able to deliver results in a timely way than the universities. R&D personnel, with the most experience of working with universities, were especially sceptical about universities' ability to deliver on time. People with PhDs were, however, less concerned with universities' than with institutes' ability to deliver results in a **short** time, which suggests that they buy different **kinds** of research from institutes and universities
- Surprisingly, customers of all kinds saw it as much more important for there to be doctoral work associated with their projects at institutes than at universities
- The availability of co-financing was unimportant to very unimportant for work done by institutes, by was important to very important in the case of universities
- Institutes' ability to help implement results was seen as rather unimportant, but the group of (predominantly) R&D people and managers who worked with universities valued implementation help from them highly, suggesting that the universities become more involved in transferring **incomplete** knowledge into R&D processes while the institutes deliver more '**packaged'** knowledge
- Ease of contacts with the partner and the partner's ability to understand the customer's needs were more important in choosing a university research supplier than an institute. We interpret this as saying that institutes' experience with contract research means these are not so important discriminatory factors as with institutes

**Exhibit 30 How Firms Use Results of Institute Projects**




*N = 42*

The work of the institutes feeds into company decision-making (Exhibit 30) and is heavily exploited in product and process innovation. A surprisingly high number are published in some way, presumably as a function of the funding for the projects, which is often partly from the state and from multiple industrial funders.

## 5.3 Project leaders' views

The six 'focus' institutes kindly provided us with samples of projects completed in 2005, so that we could ask their project leaders to characterise them, using a questionnaire. Exhibit 31 shows the numbers of questionnaires we were able to send out and the respective response rates. Since k-funded projects were evaluated in another part of this study, we excluded them from this survey.

**Exhibit 31 Project Leader Survey Response Rates**

| Institute | Mailed | Responses | % Response |
|---|---|---|---|
| **Acreo** | 17 | 15 | 88% |
| **IVF** | 34 | 32 | 94% |
| **SIK** | 24 | 20 | 83% |
| **SP** | 37 | 32 | 86% |
| **Sv Gjut** | 8 | 5 | 63% |
| **YKI** | 11 | 8 | 73% |
| **(blank)** | - | 1 | - |
| **Total** | 131 | 113 | 86% |

The projects sampled were fairly evenly spread among short, medium and long (Exhibit 32).

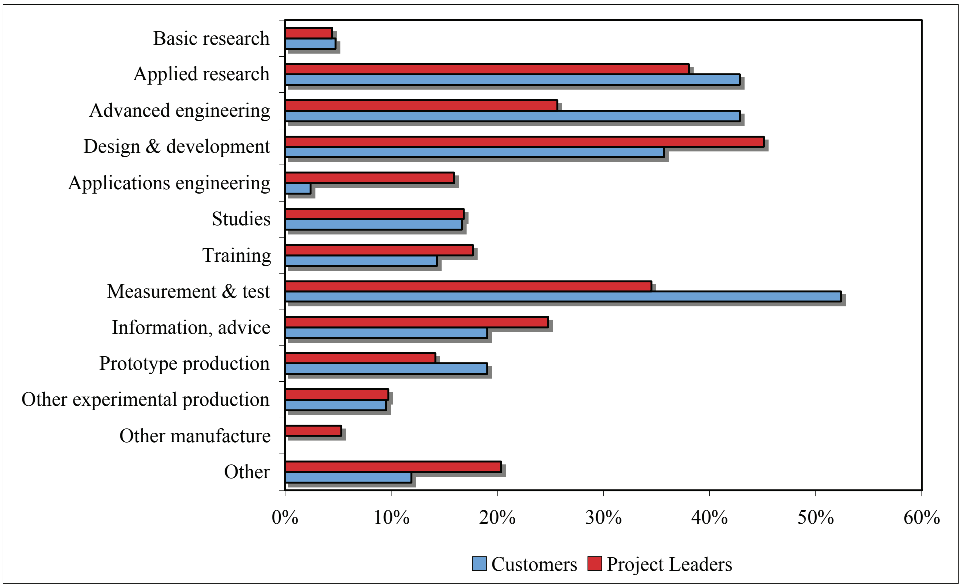
**Exhibit 32 Project Lengths reported by the Project Leaders**

| Project Length | Total | Frequency |
|---|---|---|
| Less than 6 months | 34 | 30% |
| 6 to 12 months | 37 | 33% |
| Over 12 months | 42 | 37% |
| Grand Total | 113 | 100% |

Exhibit 33 shows how the project leaders as a group saw the activities involved in their projects. Projects involving research, engineering or development were more likely than others to be long (over a year), as were projects with research or knowledge goals. Three of the four projects involving production were less than 6 months long, confirming that this is a (necessary but) rather peripheral activity.

Exhibit 33 also compares the perceptions of the project leaders with those of the customers. This should be read with caution, since these relate to different (though overlapping) project populations. There appears to be a small but tantalising difference of view, with the customers seeing R&D projects as just a little more fundamental in nature than the project leaders do. This is consistent with the 'one step beyond' idea discussed earlier, that the institutes help companies into areas that are just beyond their capabilities. The other difference of view relates to measurement and testing, where the project leaders seem to see their role as more advisory and analytical than the customers seem to think. There might therefore be scope for the institutes to do a little more marketing of the added value they bring to measurement and testing.

**Exhibit 33 Customer and Project Leader Views of Project Activities**




*N = 113 project leaders, 43 customers*

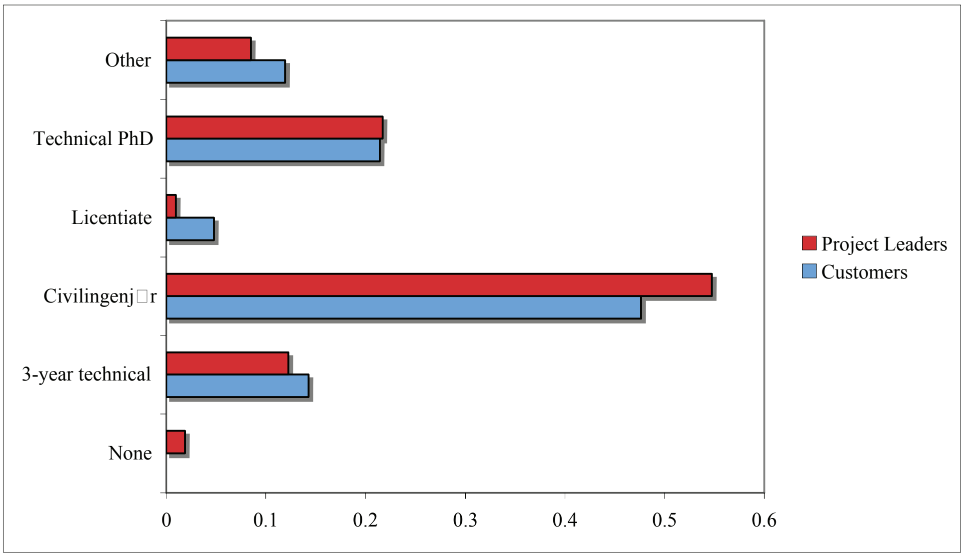
Our analysis of the main aims of the projects suggests large differences between the institutes in the way they work. Overall, product and process development is the most important activity, and it is more likely to be commissioned by a customer R&D department or other technical function than by management. It is also likely to be in or close to customers' core technologies and to involve the acquisition of technologies new to the company, evaluation of new designs and access to resources not available internally in the firm. SIK has a different profile, focusing more on knowledge development and other support for its members, while YKI is more concerned with producing knowledge that is input to companies' own product and process developments.

According to the project leaders, over a third of the customers work in management and over 40% in R&D. SP and SIK serve a lot of people who work elsewhere in the firm, reflecting the importance of testing, quality control and similar work in their portfolio.

87% of those identified as PhDs by the project leaders worked in R&D departments. People with doctorates tended to work with research institutes in order to access complementary resources, not available within the firm. They were less likely to be involved in projects to develop methods and tools than in projects with other aims, and not at all in membership-oriented projects. In contrast, people at MSc level were more likely to be involved in methods and membership-oriented projects and were more likely than average to go to the institutes in order to acquire technologies new to the firm.

In practice, the project leaders seem to understand their customers' qualifications rather well (Exhibit 34). There is a close match between the customer qualification patterns reported by the two groups.

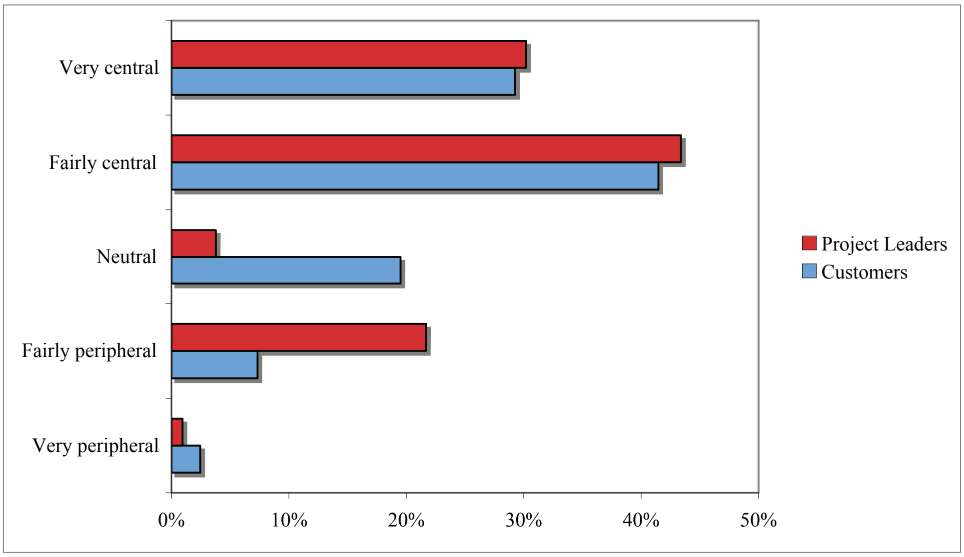
**Exhibit 34 How Project Leaders' Perceptions Compare with Customers Actual Qualifications**




*N = 106 for the project leaders and 42 for the customers*

The project leaders believed their projects generally lay within or very close to their customers' core technologies (Exhibit 35). Projects involving education, testing and information services were more likely to be in areas peripheral to customers. Comparison of the Customers' views with those of the project leaders suggests that this view is largely accurate, but that – as one would expect – the customers understand better than the institutes how projects connect to their existing technologies.

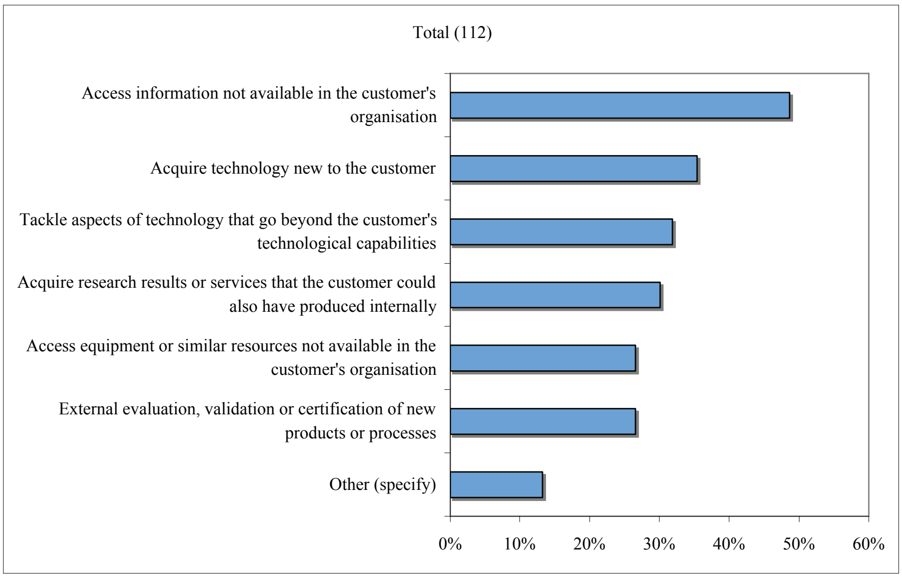
**Exhibit 35 Customers' and Project Leaders' Views of How Projects Relate to Companies Core Technologies**




*N = 106 for project leaders and 42 for customers*

Project leaders' views of customer goals are similar to those of the customers themselves, reinforcing the picture in the customer surveys of the institutes taking customers 'one step beyond' what they could normally do. Here too, however, there is an important proportion of projects that the project leaders believe the customers could have done for themselves. These projects are twice as likely as other ones to be funded out of memberships fees, so there seems to be an unsurprising trade-off between doing collective projects and getting exactly what you want.

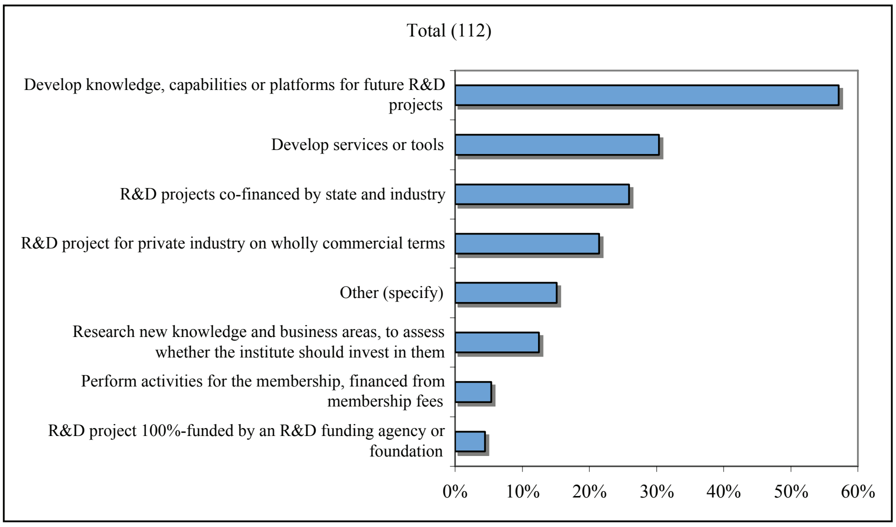
**Exhibit 36 Project Leaders' View of Customer Goals**




*N = 112*

It is interesting that the institute project leaders themselves see the value of the projects from the institute's perspective in a much more developmental way (Exhibit 37). Their concerns focus on knowledge development, service and tools development, just as they do in k-funded projects, so there is continuous internal thinking about the institute's knowledge basis and how to improve it.

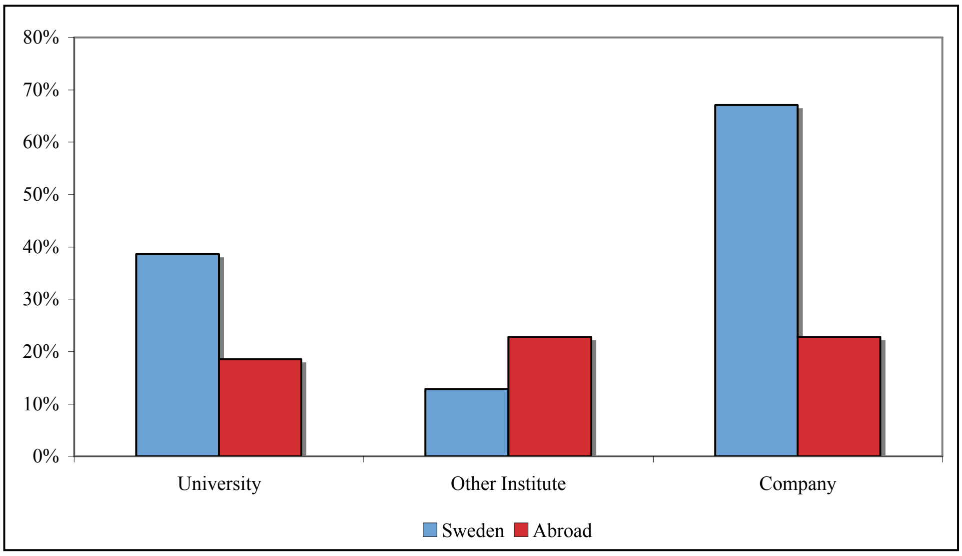
**Exhibit 37 Value of the Project from the Institute's Perspective**




*N = 112*

In the view of the project leaders, they had at least one active partner in 63% of the projects, reinforcing the high value placed on this aspect in the interviews. Partners were more likely to play an active role in projects involving research than others, and less likely to be active information projects. At least 20% of the projects had a partner abroad. Partners were most likely to be other Swedish companies or universities (Exhibit 38).

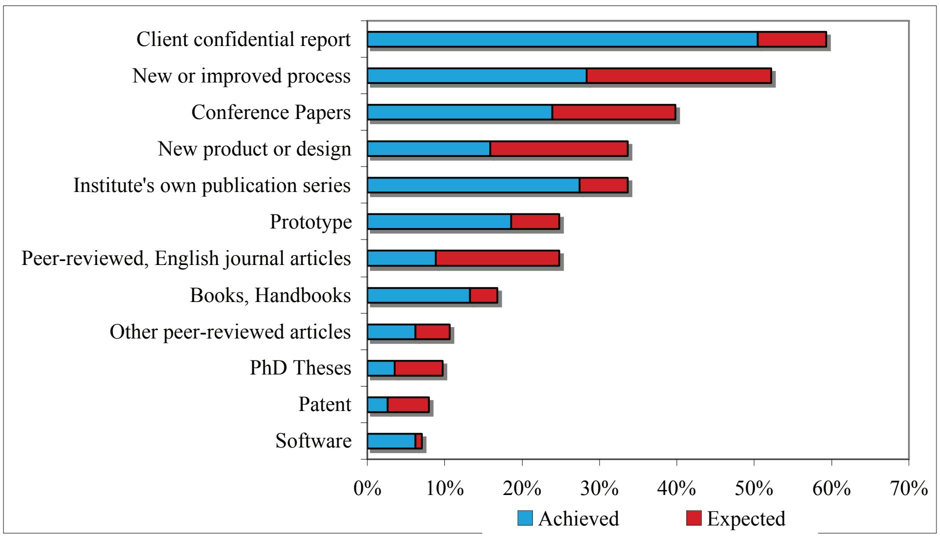
**Exhibit 38 Type of Partner in Projects that Have Cooperation**




*N = 70*

Exhibit 39 reports the proportion of projects producing outputs in various categories. Product and process designs are important results, in line with customers' reasons for going to the institutes. The high proportion of client-confidential reports is a natural function of doing contract research, but it is noteworthy how many projects have published or plan to publish in the scientific literature as well as the larger number which publish results at conferences or in the institutes' own publications series. This is a significant public good outcome. Better than 10% of projects are likely to contribute to PhD theses, underscoring both the robustness of much of the research in scientific and technological terms and the importance of the links to universities.

**Exhibit 39 Project Outputs Achieved and Expected**

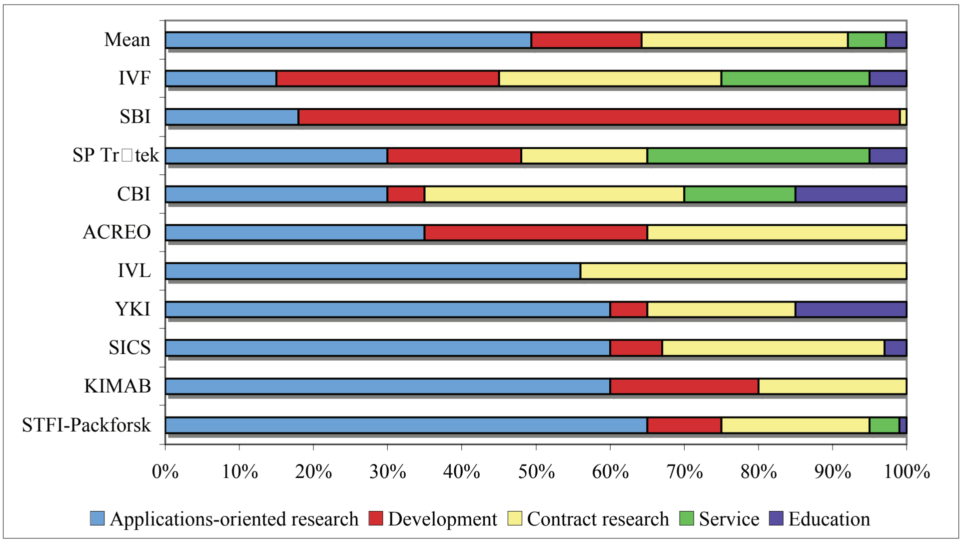



*N = 113*

## 5.4 Universities and the Third Task

In an interesting postscript to the 'Malmska' doctrine of relying on the Swedish universities to perform the functions handled in other countries by research institutes, declining state funding for use-oriented research through the 1990s has had the effect of moving even the Swedish technical universities in a 'Humboldtian' direction while new policies on IPR and commercialisation pushed the universities into seeing their innovation systems role primarily in terms of spin offs and new firm formation.[35] Eriksson and Ericsson's report on the potential for closer relations between KTH and the campus-based institutes points out how different the activities of the institutes and KTH are. Usefully, a recent study of the relationship between KTH and the industrial institutes present on its Stockholm campus included a survey of those institutes' **overall** activities, based on estimates by their managers (Exhibit 40). The differences among the institutes are striking and reflect differences in the characteristics of the branches and the technologies involved.[36]

**Exhibit 40 Self-reported Activity Profiles of Institutes based at KTH**




***Source**: Lennart Eriksson and Lisa Ericsson,* Samarbete Mellan KTH och Kringliggande Industriforskningsinstitut – nuläge och utvecklingsmöjligheter*, VR 2005:10, Stockholm: VINNOVA, 2005; Technopolis calculations*

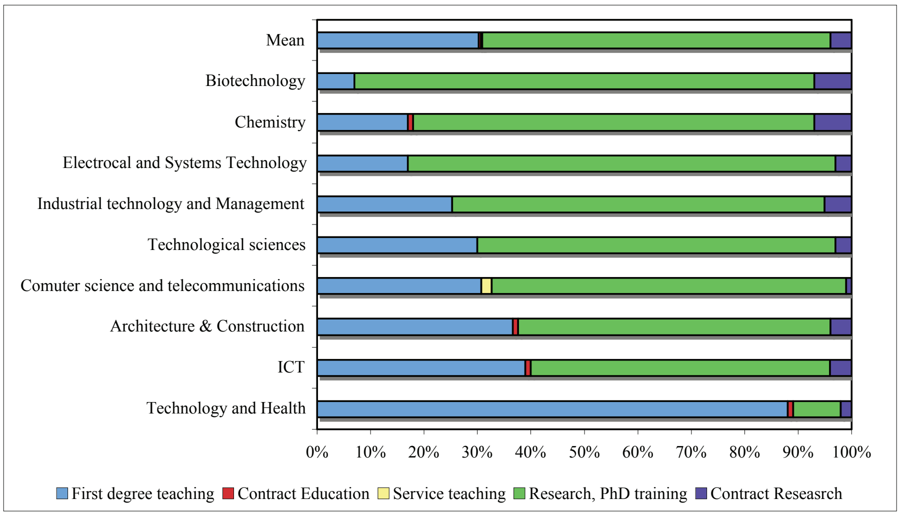
We showed their data about the institutes' activities in Exhibit 40. Exhibit 41 shows their results for nine KTH Schools. Overall, they point out that about 3% of KTH's income comes from industry, which makes it clear quite

[35] Lennart Eriksson and Lisa Ericsson, *Samarbete Mellan KTH och Kringliggande Industriforskningsinstitut – nuläge och utvecklingsmöjligheter*, VR 2005:10, Stockholm: VINNOVA, 2005

[36] They probably also reflect some differences in the use of terminology, but that is difficult to control for

how marginal any institute-like function is even in a Swedish technical university.

**Exhibit 41 Self-reported Activity Profiles of Sample KTH Schools**




***Source**: Lennart Eriksson and Lisa Ericsson, Samarbete Mellan KTH och Kringliggande Industriforskningsinstitut – nuläge och utvecklingsmöjligheter, VR 2005:10, Stockholm: VINNOVA, 2005; Technopolis calculations*

Our study of the institute k-funds made it clear how extremely important it is for the institutes nonetheless to have intellectual links with universities, especially via doctoral training. Eriksson and Ericsson in effect point out the ability of the institutes to provide industry networks (complementing universities' existing ones) and to act as 'focusing devices'[37] that communicate areas of industrial problem and interest to universities, which in the applied sciences at least tend always to be problem-hungry. The international component of this study showed that close university-institute relations are central to most of the other European organisations. Where we do part company with Eriksson and Ericsson, however, is in their insistence on clear rules, clear division of labour and general tidiness as a useful prescription for what is in fact a messy reality where the boundaries are in constant change. They appear to want to reinstate the 'three hump model' of university – institute – industry relations that does not work, and that probably never did. The more science-based innovation and technology become, the more important it is for the work of the universities and research institutes to overlap.

In this part of the work, we have done three case studies of how universities are tackling what they see as institute-like functions, in pursuit of their 'third task'.

[37] Nathan Rosenberg, *Perspectives on Technology*, Cambridge University Press, 1976

KTH has for some years been running an Entrepreneurial Faculty project that increasingly tries to see the third task as integrated with the first two tasks, not as something separate. In this sense, the university's thinking is very modern and explicitly connected to the ideas of Clark[38] and Etzkowitz[39], who are generally credited with coining the term 'entrepreneurial university', Clark arguing that such a university would have

1 A strengthened steering core
2 An extended developmental periphery, eg professional relationship handling
3 A diversified funding base
4 A stimulated academic heartland
5 An entrepreneurial culture

Curiously, the report of the Entrepreneurial Faculty project does not mention the industrial research institutes at all[40], which Eriksson and Ericsson regard as offering a major contribution to Clark's second characteristic.

In recent years, like other Swedish universities, KTH has strengthened its Industrial Liaison Office, established a holding company for intellectual property and increased the resources it devotes to commercialising inventions. In parallel, the School of Industrial Management and Engineering established the Engineering Institute (EI) in 2002, to provide a direct interface between the school and industrial customers. It is run by a single person, who brokers contacts within the school (and KTH more widely), and project manages industrial assignments. Most projects are short (1-3 weeks) and involve tailor-made training or a rapid application of scientific and technological tools (especially design and analysis software) and know-how in engineering projects. Customers are usually technically well qualified, so that KTH can supply research-relevant knowledge without a great deal of further packaging. There is a discussion about allying with a large commercial technical consultant to tackle the more routine parts of projects and increase project sizes. EI participation is completely voluntary for KTH faculty, so it is hard for the university to staff long or routine kinds of assignment without an external partner. By 2005, EI's project volume had risen to 3.5 MSEK, which may be as much as one person can handle.

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[38] B Clark, Creating Entrepreneurial Universities: Organisational Pathways of Transformation, Exford: Pergamon-Elsevier Science, 1998
[39] Henry Etzkowitz, 'The Evolution of the entrepreneurial university,' *International Journal of Technology and Globalisation*, 1 (1), 2004
[40] KTH Faculty Board, *The KTH Entrepreneurial Faculty Project*, Report VR 2005:13, Stockholm: VINNOVA, 2005

Chalmers Industriteknik (CIT) was set up in 1984 as a foundation separate from Chalmers to exploit the university's R&D capabilities in industry. In effect, it handles Chalmers' Industrial Liaison and IPR functions, while also brokering projects with Chalmers faculty (similar to KTH's EI, accounting for 20% of CIT's turnover) and owning a handful of university spin-off companies. Two thirds of the 27 staff have PhDs and 60% have been recruited from industry, in an effort to ensure that CIT understands the industrial context. They work mostly with large companies, especially in the Gothenburg area, where Chalmers is located.

Like EI, CIT functions primarily as an extended form of Industrial Liaison office for the university. Both clearly do valuable work, not least in extending the networks of the academics, who then sometimes cut themselves loose from the brokers EI and CIT and build their own industrial networks directly.

The Casting Innovation Centre (CIC) at the University of Jönköping is interesting for this study because it was set up in response to the needs of the Swedish Foundry Association for an academic partner. Volvo and Scania were key drivers and part-funded a chair in Jönköping, attracting a professor from KTH to establish a research group. As a result, there is both a flow of PhDs to the Association and its members and stronger research underpinning the Association's work.

While CIC was a more or less virtual organisation during its first years, it has nonetheless grown to group together about 40 researchers (including 15 PhD students). Recently, it won a VINNOVA Institute Excellence Centre grant together with SFA, providing a prospect of expanding the centre, drawing in more companies and developing a longer term strategy with the SFA than has been possible on the basis of project-by-project funding to date.

CIC represents a radically different way to work with industry compared with EI or CIT. Rather than offering a rather small-scale brokerage to widespread university resources, with all the limitations that entails, CIC has an explicit partnership that enables it together with SFA to offer a complete and professionalised set of research and service capabilities stretching from basic research and PhD education through to testing.

# 6 Conclusions and Policy Implications

This Chapter draws on the material in the report in order to generate conclusions, on which we base policy recommendations for Sweden.

The institutes play an important role in the innovation system by helping companies move ‘one step beyond’ their existing capabilities and reducing the risks associated with innovation to allow a faster rate of economic development. They typically use a three step innovation model: building capabilities, using core funding and other resources such as cooperations with universities; extending these in pre-competitive work with industry; and finally using them to deliver services as the technologies mature.

While institutes and universities increasingly overlap and cooperate in knowledge production, they are complements not substitutes, having different skills and core capabilities. Companies normally cooperate with institutes when they need directly applicable knowledge and with universities in order to obtain human resources. There is no evidence to support the ‘Swedish model’ and the idea that universities can substitute for what institutes do. Industry does not make greater use of universities in Sweden than in other countries, nor do Swedish universities in practice supply the same services as the institutes. Institute-like activities are completely marginal in the Swedish university system.

Swedish research and innovation policy needs to assign a larger, better-funded and more long-term role to the industrial research institutes, whose role needs to be better integrated into broader innovation policy. Institute managements need a base of resources and strategic freedom in order to develop and implement strategy. The Swedish institutes’ resources for developing capabilities are undoubtedly too small and should be increased. A financing model is needed that combines more core funding with other instruments that encourage the institutes to develop technologies to address social needs, promote interaction with universities, fund participation in international cooperations and provide incentives for internationalisation of the institutes’ activities.

## 6.1 What industrial research institutes do

We can see three broad categories of industrially focused institute, based on differences in history that tend to persist as differences in behaviour.

- Research associations, which originally tackled common problems within one or more branches of industry and then became institutionalised in the form of institutes. (The growth of Mekanförbundet, which eventually established IVF is a good Swedish example.)  Some of these are still membership based
- ‘Technology push’ institutes, sometimes set up in the more recent past, in order to promote industrial development more widely. SINTEF is an older example. Fraunhofer is also in this category, since its modern role was created by transforming an earlier small institute network that had other purposes
- Services-based institutes, generally focusing in their early years on measurement, testing and certification. Like the Swedish SP, these have moved ‘upstream’ into research. Arsenal Research is a clear example. VTT is a mixed case where a policy decision was taken to transform a services-focused institute into a technology push institute

The first two categories tend to have an emphasis on research in their portfolios, while the third naturally mixes research with a higher services component.

This study shows that the institutes support strong and established industry as well as smaller and newer firms by reducing the risks of innovation. Technically, they help different companies in different ways, providing more advanced and scientifically demanding help to the more sophisticated users. The range of activities they perform is wide, but focuses especially on applied research and development and on testing-related services. What these different types of help generally have in common is that they take firms ‘one step beyond’ their existing capabilities and let them innovate more, sooner and with less risk than would otherwise have been the case. Institute projects are therefore not substitutes for internal projects and there is no question of institutes ‘crowding out’ internal R&D activities. Where the needed ‘one step beyond’ is into more fundamental science, companies may turn to universities or institutes in combination with universities in order to access the needed knowledge. They may also use competence centres.[41]

The institutes are important and valued partners of the organisations we interviewed. Knowledge networking matters. For many firms, the institutes are an interface to the world of scientific and technological knowledge. They need access to the literature, to universities and to institute capabilities outside Sweden, in order to fill gaps or provide access to more advanced capabilities than exist in Sweden.

[41] Erik Arnold, John Clark and Sophie Bussillet, *Impacts of the Swedish Competence Centres*, Stockholm: VINNOVA, 2004

In order to reduce innovation risk on behalf of society, institutes use a three-step innovation model to develop unique skills and assets. Core funding is one of the ways they develop and refresh their competences, establishing new capabilities and technology platforms. They further develop knowledge in partnership with more technically sophisticated company research partners, and in a third stage provide less sophisticated services to companies with lower levels of technological capability as technologies mature.

Institute scale is important. Industry's needs for support from institutes are generally shorter term than in the areas where industry turns to universities. Individual companies' demand can therefore be volatile so institutes do well to have quite large customer portfolios, ironing out these statistical variations. Since customers seek access to technically specialised resources, larger, polytechnic institutes are better able than smaller ones to meet needs.

The knowledge infrastructure is part of global competition and needs to act internationally, like its globalising customers. The institute sector, however, has so far failed to move internationally with its customers. We speculate that there may be important first-mover advantages for institute groups that lead the process of internationalisation, including the delivery of increased intellectual and human capital to their 'home' countries and regions.

There is pressure for increased quality and specialisation, as well as scale. Even just to serve operations located in Sweden, institutes need to market their capabilities abroad at the headquarters of multinational firms.

It is widely assumed that one of the functions of research institutes is to serve less technology-capable companies, often SMEs. Institutes in some countries are explicitly organised and funded to do this. Doing it well depends upon having quite specific skills in marketing and interacting with SMEs. But this is only one of many possible ways to specialise institutes' strategies. For some institutes, SME support may be as alien a task as it is for universities, and it may be as badly done in both cases.

A recent requirement on a number of institutes has been that they engage in 'commercialisation' activities, by analogy with the way universities have been encouraged to increase the extent to which they commercialise their discoveries and inventions, generally as part of a 'third task' or 'third stream' of activity. This is in large part a category mistake, based on thinking about institutes in the same way as universities. In performing their core roles in risk reduction, institutes are already functioning as 'commercialisation machines,' transforming research in the early stage of the pipeline into projects and results at the second and third stages of the pipeline that are useful in existing industry. There are sometimes opportunities to license or spin off research results from the first stage of the pipeline but institutes have to be very careful to avoid doing so in ways that lead them to compete with their customers.

## 6.2 Institutes and universities are not substitutes

The roles of the universities and the research institutes in the knowledge infrastructure are complementary, not substitutes. This has profound implications for institute funding policy. Not to put too fine a point on it, Swedish policy has got this wrong for most of the last 60 years. It follows that the recent increases in Swedish institute core-funding need to be part of a policy over time to recognise the real role of the institutes and to fund it accordingly.

In modern knowledge production, there is growing overlap among the roles of companies, institutes and universities. It is pointless to try to enforce a strict division of labour that goes against the ‘business logic’ of running these three types of organisation. Both companies and universities are in different ways sources of key inputs to identifying and developing needed new competences in the institutes. In this connection, institutes need tight intellectual partnerships with universities, just as the universities benefit from institutes’ ability to act as ‘focusing devices’ that identify areas of interest and with interesting problems.

In contrast to the universities, institutes use much more structured and quasi-industrial approaches, with disciplined project management, quality control, business information systems and strong cost monitoring and control, milestones and stage gating. Their researchers are on average older than those at universities (where the research workforce is numerically dominated by doctorands) and more experienced. They tend to have experience of manufacturing and understand how to scale up new techniques to a point where they are industrially useful. They are often equipped with specialised test and measurement equipment and sometimes pilot plant not readily available elsewhere. They have routines for the confidential treatment of proprietary knowledge, so that it does not leak into the research literature or other parts of the public domain. Crucially, providing research and technical services to industry tends to be core business for an institute, whereas for universities these are peripheral activities that may even conflict with allocating resources to the two core missions of teaching and research.

Institutes are especially useful to industry when it needs externally generated knowledge that is timely and can directly be exploited in industrial practice or used to make decisions. Often, it is important that the institute can undertake work at short notice. Research institutes tend to assign intellectual property rights over new knowledge to their customers, while this is harder for universities in Sweden, where university teachers own the rights to their own inventions.

Companies appear to buy different things from institutes (as compared with universities or technical consultancies) for different reasons. Research projects should involve a higher degree of risk or access to more fundamental knowledge than those customers would entrust to a consultancy. Equally, there are areas of research and technology where there is no offer from private consultants. Because institutes have better project management processes, the act of contracting a research project with an institute and not a university is itself a way to reduce the risk of project failure or of the project delivering results too late to be useful.

Companies' use of institutes and universities is rather distinct. It is important to note that a fair amount of large company interaction with universities is done for reasons of 'citizenship' – not least to secure a future supply of needed human resources – and not in order to secure knowledge with a short-term, practical application.

The effort of the universities in recent years to develop their Industrial Liaison functions and to commercialise more of their discoveries and inventions is a useful extension of their role. However, this does not in any meaningful way substitute for the role played by the institutes. The things the institutes deliver are at best marginal to universities' core skills and activities. Closer partnerships with institutes rather than attempted competition is the best way for these two types of institution to serve society's interests. It follows that R&D policy needs to support the core missions of both institutions and create incentives for their cooperation.

Transparency in institute funding is likely to improve performance. However, in the context of modern 'Mode 2' institutes, this is only possible if both use a meaningful full economic cost modelling system (as has recently been installed in the UK universities).

## 6.3 The importance of management

Our interviews with institute managers both in Sweden and abroad suggest there are some special characteristics in institute management that are not necessarily present in other kinds of organisations.

All leaders of organisations that operate in markets find themselves, in a sense, fighting a war on two fronts. On the one side, they have to do battle in the market, beating competitors and satisfying customers. On the other side, they have to battle with and reward the people inside the organisation in such a way that they allow the organisation to achieve its objectives. In the conventional oversimplification, this is about how much to pay the workers. In institutes, it is especially clear that money is not the only motivation. The ability to do research and participate in research communities is an important part of the reward system, and this provides an additional constraint on how much of the institute's effort can be devoted to routine development and services (stage 3 in the description above).

While there are therefore some similarities with academic management, in so far as the staff of a research institute needs at least semi-academic rewards, institute managers are also under strong pressure to run their organisations in a businesslike way. Generally, the aim is to break even rather than to make money, but there is nonetheless a clear economic goal and this requires strategy. Resources to develop and pursue strategies are scarce, hence institute managers focus on the need for un-earmarked core funding because this gives them strategic freedom. Cycles for developing and exploiting new knowledge capacities can be relatively long, so managers also look for predictability in at least part of their income, allowing them to plan. Given less predictability, planning has to become shorter term, and this undermines the role of the institute as accessing and exploiting knowledge that is somewhat 'ahead' of industrial practice.

## 6.4 The role of core funding

Most of the institute managers we interviewed, both in Sweden and abroad, viewed (increased) core funding as the solution to all problems. Some argued that too much core funding leads to inefficient slack within the organisation. None was able to say what the right level of core funding is and to provide an argument to justify this level. Nonetheless, management concerns do suggest that a funding system should

- Contain an element of un-earmarked core funding, in order to generate the opportunity to follow a strategy rather than being forced always to follow short-term market behaviour
- Be multi-annual, in order to create the degree of *Planungssicherheit* required to do risky research or to make responsible investments in infrastructure
- Be consistent with the internal reward systems in institutes, in which membership of a research community and the ability to do research are important elements
- Address EU co-funding (if this is not done elsewhere in the state R&D funding system)

We think, however, that a more nuanced policy approach than 'more core funding' is needed.

On the face of it, it is puzzling that the state should play a role in institute funding. It is well established that investments in research on average yield good returns, and this ought to be sufficient to persuade the private sector to invest.

The traditional argument for funding research institutes is market failure. That is, that the characteristics of research (uncertainties, scale, inappropriability) make it difficult for firms to invest at the level of the individual project. The skewed nature of innovation outcomes, where most innovation projects produce poor returns but a handful produce very large ones, adds further weight to the market failure argument. As a shorthand, we tend to say that subsidising institutes reduces innovation **risk**. It therefore supports industrial development by increasing the rate of innovation and allows firms to make more radical innovations based on longer-term or more fundamental research than they could otherwise undertake.

This argument, however, neglects the **public goods** character of institute systems. Additional arguments for subsidy arise from the institutes' role as knowledge infrastructure – both in the sense of available R&D capacity and in the sense of providing services such as measurement and advice – that supports the operation of industry and helps make it attractive to invest in Sweden.

Where institutes provide SME support services, there is an additional and separate logic for subsidy, involving the provision of an additional infrastructure to such firms and compensating for inadequacies in their internal capabilities.

These arguments suggest that there is not a single subsidy or state funding logic for institutes but that separate arguments apply to separate categories of institute activity. Different arguments apply in different contexts. For example, in a large economy with a well-developed metrology market, there is less likely to be an argument for funding the provision of metrology services by institutes than in a small economy that does not support such a market. SME services may be provided by institutes or by other organisations. There is a choice in funding about where the state buys such services on behalf of society. Correspondingly, there are arguments for a **segmented** approach to institute funding, as opposed to providing generous and un-earmarked core funds.

Institutes are able to perform the roles discussed in Section 6.1 because they have better access to knowledge and other resources than is available to wholly market-based institutions. This superior access may be through one or more of the following mechanisms

- Core funding, in the sense of an un-earmarked subsidy paid to the institute, which allows it to fund the acquisition or generation of knowledge and instrumentation
- Subsidy specifically earmarked for developing capabilities (whether acquired by negotiation or in competition with other institutes), such as the Swedish K-medel
- Other R&D funding instruments that have the effect of increasing institute capabilities, such as the Danish innovation contracts or VINNOVA's new-style competence centres programme that finances institute participation
- PhD scholarships, allocated to the institute to fund people studying there
- PhD scholarships, allocated to others, where the doctorands in practice work at or in collaboration with the institute
- Other resources, such as faculty time and instrumentation, shared with universities

Comparisons between institute financing systems normally consider only the first two items on this list. However, for some institutes (SINTEF, IMEC, Fraunhofer, among others) synergies with universities are major sources of capability. British experience with the research associations illustrates that when such non-market based sources of capability are removed, institutes degenerate into consultancies.

The k-funding provided to the IRECO institutes generates significant value for the institute system. The amount of money involved is small – too small – but it makes much of the difference between having an institute sector and having a set of partly state-owned technical consultancies. The proportion of core or capability-building funding provided to research institutes is **the** key parameter that determines what they can do. If a modern, knowledge-based economy needs modern, research-based and internationally competitive institutes, then it also needs to fund them sufficiently that they can have these qualities. While there is no absolute way to determine what the right level of capability-creating funding should be, the foreign competition has rather clearly set the benchmarks at about twice the level discussed in the 2005 Research Bill. In that sense, Sweden has a long way to go in establishing a fully viable institute system.

The development of the institute system continues to be hampered by the over-large influence of its industrial stakeholders. Combined with the small scale of available capabilities funding, this influence continues to limit modernisation in the sector. The creation of the four 'clover' institutes offers a significant opportunity to contain this influence, and to establish a more productive, market-like relationship between stakeholders and institutes where the institutes have greater strategic freedom.

Funding is not the only problem. Governance and consistency of policy across the research and innovation system are important. Disinvestment in the institute sector appears partly to have been an unintended consequence of creating new funding organisations. Fragmenting the responsibility for looking after the sector among many organisations – IRECO, the KK Foundation and VINNOVA – may be pragmatically useful in terms of accessing different funding streams, but does not encourage clear or consistent policymaking. The lack of strategic intelligence resources in the Industry Ministry has probably also contributed to the difficulty of devising and maintaining a consistent policy for supporting the institute sector.

## 6.5 Policy implications for Sweden

### 6.5.1 Short term actions

It is clear both from the internal analyses in Sweden and the comparisons with institutes abroad that the amount of k-style funding provided to the Swedish institutes needs still significantly to increase, but to be granted via clear performance contracts to contain the development of slack and hinder cross-subsidy. Increased k-funding will increase the institutes' willingness to take risks. It should be accompanied by conditions that limit industrial stakeholders' power to take decisions about the money.

Allocating k-funding at the level of the four 'clover' institutes rather than the former, smaller organisations will additionally strengthen institute managements' ability to develop and implement strategy. The broad lines of strategy need nonetheless to be contested in a dialogue between a funder and the institutes that entails competition among the institutes, systematic and standardised data-collection and monitoring of agreed performance indicators from the institutes over time, and periodic evaluation of the institutes. Mechanisms are needed that (a) have the effect of allowing the institutes and their Strategic Business Units to make 3-year capability plans and roll them annually and (b) retain a degree of slack that can be used for contingencies and unexpected requirements.

A de facto increase in capability funding can be achieved through the use of innovation instruments that generate reusable intellectual capital in the institutes. VINNOVA should review instruments such as AIS, as well as examining the Danish experience, with a view to incorporating such an objective in its wider activities.

As technologies become increasingly science-based, the need for overlap between the functions of the institutes and the universities increases. A second type of instrument that would de facto increase capability funding would be specific ‘institute doctorand’ grants. VINNOVA should explore mechanisms through which such grants could be created.

EU Framework Programme participation often has a similar effect to capability funding. A de facto increase in capability funding can therefore also be achieved through selectively providing matching funds to allow the institutes to participate more broadly in these programmes.

A single agency should have overall responsibility for the institute sector. Given the need for consistency among policies, this should be the innovation systems agency. If necessary, it can act as agent for other money-providers in order to collect the required budget in a single place.

It is not clear that industrial ownership makes a positive contribution to operating a modern industrial research institute. It may be useful to bring the Swedish institutes into full state ownership.

The activities of the institutes are not substitutes for the loss of the ‘development pairs’ that formerly characterised important parts of the Swedish innovation system. Other policies are needed. It will be useful to participate in the growing European debate about technology procurement and to devise appropriate policies.

### 6.5.2 Longer-term policy

In order to allow the institute system to play a proper role in Swedish industrial development, a longer term funding policy is needed. This should set the course for the foreseeable future, and not restrict itself to the period covered by the current Research Act. An important gap in the Act is to state a longer-term **policy** for institute funding. The time horizon considered goes no further than 2008, leaving expectations for core funding and the expected role of the institutes beyond 2008 unclear. It should have at least a rolling three-year perspective, so that each year the institutes have a fairly high degree of certainty about their financial future and can roll forward their three-year plans. The main planks of such a policy should be

- A long term commitment to the idea that the industrial research institutes play a legitimate and important role in the Knowledge Infrastructure of the Swedish innovation system
- A recognition that this role depends upon the provision of core funding that allows the institutes to take over some of the technological risks of innovation on behalf of society in ways that are not possible in the private sector. The state should therefore provide this funding, and should also be the sole or principal owner of the institutes
- An expectation that the size of the industrial research institute system may grow moderately over time, based on its ability to contribute to

Swedish industrial competitiveness and the attractiveness of the country as a location in which to perform industrial activity

- The idea that this ability will in large part be measured by the willingness of industry (whether based in Sweden or elsewhere) to pay to use the services of the institutes and by the institutes' ability to demonstrate their competitiveness in obtaining national and international R&D funding grants
- The principle that the institutes should maintain close and cooperative relations with universities (whether in Sweden or abroad) so that each type of organisation benefits from the other's complementary assets and skills
- A principle of internationalism, that permits and encourages the institutes to pursue their role beyond the national borders and participate in the international division of labour

### 6.5.3 A funding model for the Institutes

Core funding is the defining characteristic of the institutes and the thing that allows them to play their role in the innovation system. It needs to be big enough to allow strategy to be made and implemented, but a more programmatic component is needed if the state wishes to steer institutes towards particular tasks, such as SME support.

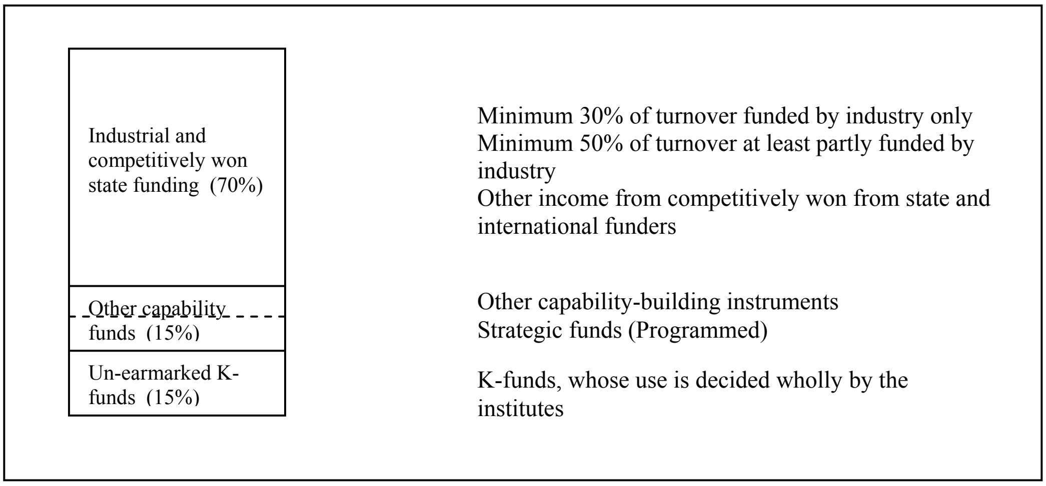
The thinking here is influenced by the Fraunhofer model, which envisages a roughly equal split between: core funding; projects involving some state funding but won in competition; and wholly industrial income. Fraunhofer allocates a significant part of the core funding to individual institutes on the basis of their sales performance in the previous year, so there is a strong feedback loop from what institutes achieve to how much core funding they get. In addition, Fraunhofer's central management can allocate strategic funds with the aim of encouraging the institutes to cooperate or start to work in new directions. The suggested financing model for the Swedish institutes similarly combines rewards for past performance with a prospective element. However, the suggested level of core funding is lower than at Fraunhofer, because other sources can be used to provide equivalent capabilities funding.

We get a second source of inspiration from the 'invisible' core funding that institutes like SINTEF get from cohabiting with universities, so the model aims to encourage co-working between universities and research institutes. A third source of ideas is the practice in some countries of running R&D support programmes that partly aim to build competence in research institutes.

Exhibit 42 shows the broad model we propose for future funding of the industrial research institutes. It envisages three income streams for the institutes

- A block of un-earmarked core funding, to be used for competence building. These correspond to the k-medel allocated to the institutes in recent years and should be used as part of the institutes' **own** knowledge development strategies
- A second amount of money should be available as an incentive to the institutes to build capacities in areas prioritised by society, through the state. This has two components
  - 'Strategic funds', which are capability development funds to be spent on things specified by funding agencies, rather than on things completely freely determined by the institutes, such as additional cooperation with universities, post-merger integration within the four-leaf clover or bonuses to reward those who win large amounts of EU money
  - Other R&D funding instruments that have a capacity-building element, as in the Danish Innovation Consortia, the Norwegian Strategic Institute Projects or the VINNOVA/SSF/KK Institute Excellence Centres programme
- The balance of the income should derive from an appropriate mixture of private and publicly-funded projects, won in competition with others

**Exhibit 42 Model for Future Institute Funding Policy**




Core (capability development) funding from a range of sources totals about 30% of revenues. If this proportion grows much larger, the institute provides little 'leverage' for society's investment in reducing the risks of innovation to pay off, and the opportunities for the institutes to use core funding to cross-subsidise projects or for other inappropriate purposes become too large. Since these are industrial institutes, the bulk of the income and activity should be closely tied to industrial needs and working with industry, which is why the model has minimum requirements for industrial and industry-related funding, while still leaving space for relevant projects won in national and international state funding competitions.

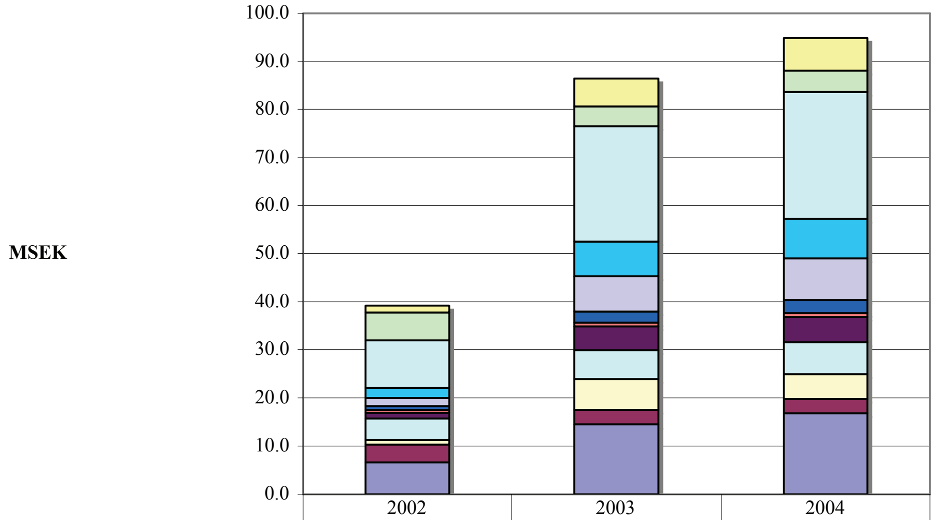
The principles for allocating capabilities funding should be as follows

- The un-earmarked element of core funding should be driven by the overall turnover of the institute, which reflects the amount of need it successfully addresses and the institute's competitive success. Ideally, this should be 15% of institute turnover and should be allocated ex post, subject to the institutes satisfying the requirements to serve industry. At the start of each year, therefore, the budget for institutes' un-earmarked k-funding should be distributed pro rata their share of the total turnover of all the IRECO institutes
- Strategic capability funding should be allocated on the basis of institutes' success in addressing strategic priorities (such as cooperating with universities, restructuring, etc). For established priorities, this should be assessed ex post. For new ones, allocations will have to be made ex ante.

# Appendix A
# Appendix to Chapter 3

Exhibit 43 shows the allocation of K-funding to the institutes for 2003 and 2004, as well as the much smaller amount allocated for 2002, at which time the core funding from the industry ministry was winding down.

**Exhibit 43 K-funding Allocations, 2002-2004 (MSEK)**




| | 2002 | 2003 | 2004 |
|---|---|---|---|
| YKI | 1.4 | 5.8 | 6.8 |
| Tr□tek | 5.9 | 4.1 | 4.5 |
| STFI/Packforsl/Framkom | 9.8 | 24.0 | 26.4 |
| SIK | 2.1 | 7.2 | 8.2 |
| SICS | 1.7 | 7.3 | 8.6 |
| SGF | 0.8 | 2.4 | 2.7 |
| SCI | 0.6 | 0.8 | 0.9 |
| Mefos | 1.2 | 4.9 | 5.3 |
| KIMAB | 4.4 | 6.0 | 6.6 |
| IVF | 1.0 | 6.4 | 5.1 |
| IFP-SICOMP | 3.7 | 3.0 | 3.0 |
| ACREO | 6.6 | 14.5 | 16.8 |

The greater number of the institutes planned to use k-funding in conjunction with a contribution (typically about 25%, but ranging from 17-44%) from their member companies. Acreo, IVF and Trätek did not plan to provide complementary funds. YKI followed a different strategy, pursuing partnerships with a range of universities (KI, KTH, LiU, CTH, LU) via PhD candidates and with the institutes SCI and FRAMKOM, allowing it to innovate in new fields of application for surface chemistry.

**Exhibit 44 Extent of Co-Funding of K-Funds by Institute Members**

| Institute | % of capabilities Budget funded by Members | % of capabilities Budget funded by others |
|---|---|---|
| Acreo | - | - |
| IFP-SICOMP | 25% | - |
| IVF | - | - |
| KIMAB | 25% | - |
| MEFOS | 17% | - |
| SCI | 44% | 12% (KK) |
| SGF | 33% | - |
| SICS | 28% | - |
| SIK | 39% | - |
| STFI | 21% | - |
| Trätek | - | - |
| YKI | 26% | - |

***Source****: Institutes' k-funding plans*

Exhibit 45 shows that the range of activities performed within k-funded projects at most institutes is quite wide. Given the limited numbers of responses, the absence of a category at an individual institute does not necessarily mean that the activity is not performed there.

**Exhibit 45 K-funded Project Activities per Institute**

| | Basic research | Applied research | Adv. Eng./ Exp. Dev. | Design and dev. | Appl. Eng. | Studies incl. market studies | Edn. and training | Other |
|---|---|---|---|---|---|---|---|---|
| Acreo | | | Y | | | Y | | Y |
| Corrosion Institute | Y | Y | Y | Y | Y | | | |
| IFP Research | | Y | Y | Y | | | Y | |
| IVF | | Y | Y | Y | | Y | Y | |
| KIMAB | | Y | | Y | Y | | | |
| MEFOS | | Y | Y | Y | Y | Y | Y | Y |
| Santa Anna | | Y | | Y | | | | |
| SICS | Y | Y | Y | | | Y | Y | Y |
| STFI-Packforsk | Y | Y | Y | Y | Y | Y | Y | Y |
| YKI | | Y | Y | Y | | | | |

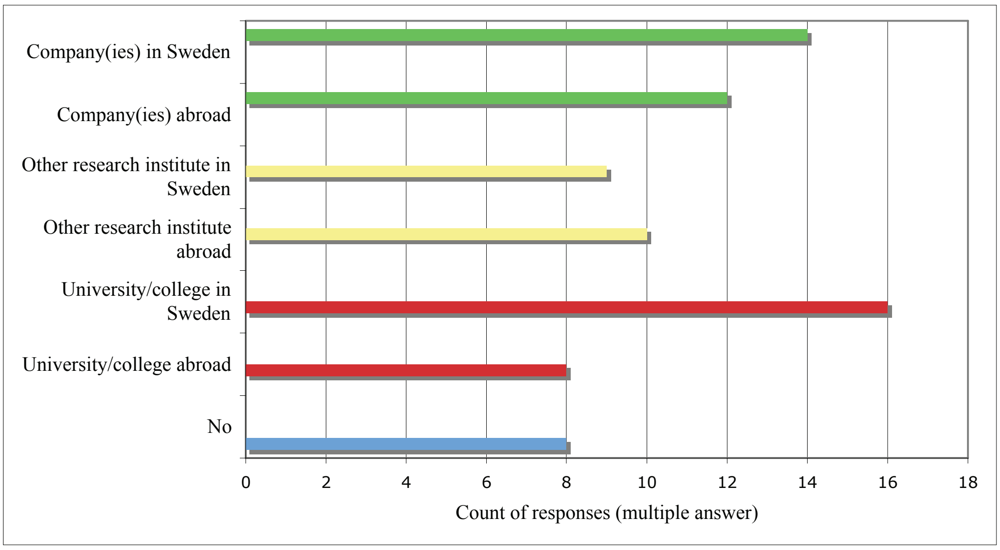
*n = 37*

**Exhibit 46 Other Funding Sources in K-projects by Institute**

| | EU or Eureka | Swedish R&D funding agency or foundation | Funds from member companies or owners | Other industrial funds | Other |
|---|---|---|---|---|---|
| Acreo | | | | Y | Y |
| Corrosion Institiute | Y | | Y | | |
| IFP Research | Y | | | | Y |
| IVF | Y | Y | | Y | Y |
| KIMAB | | | Y | Y | |
| MEFOS | Y | | Y | Y | Y |
| Santa Anna | | Y | Y | Y | |
| SICS | Y | Y | Y | | Y |
| STFI-Packforsk | Y | | Y | Y | Y |
| YKI | | | | | |

Exhibit 47 indicates that only about a fifth of the projects are done internally in the institute, without networking with others. Half network with Swedish universities and about the same number with companies. In this respect, the institutes' international reach is surprisingly good. The extent of networking with other institutes is also interesting, though it is no doubt influenced by the cooperation incentives provided in the 'structural' k-funding.

**Exhibit 47 Cooperation with Others in the K-funded Projects**



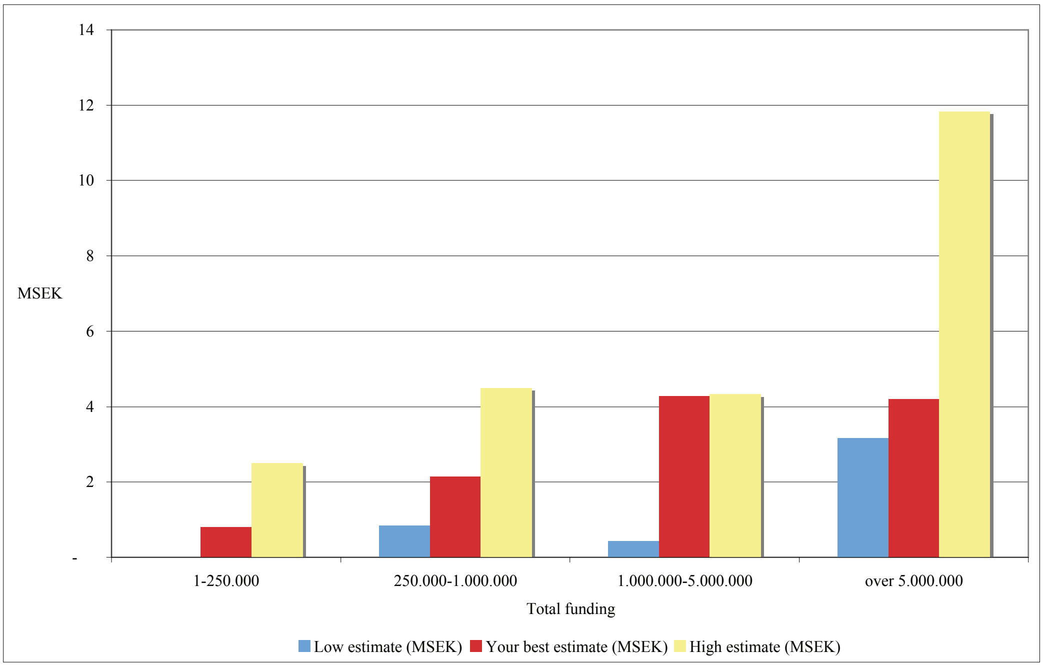

*n = 37*

**Exhibit 48 Mean Estimates of Income Resulting from Project After 2 Years**

| | Av. Mean | Std. dev. | Mean - S.D. | Mean + S.D. | n. cases within range |
|---|---|---|---|---|---|
| Low estimate (MSEK) | 1.04 | 2.22 | -1.18 | 3.26 | 88% |
| Your best estimate (MSEK) | 2.63 | 4.04 | -1.41 | 6.67 | 93% |
| High estimate (MSEK) | 5.56 | 6.72 | -1.16 | 12.28 | 92% |

*n = 26*

**Exhibit 49 Mean Expected Year 2 Income by Project Size**



# Appendix B
# Appendix to Chapter 4: Case Studies of Comparator Institutes

This Appendix summarises and discusses information collected about seven foreign comparator institutes and institute systems

- SINTEF, Norway
- GTS, Denmark
- VTT, Finland
- TNO, Netherlands
- IMEC, Belgium
- Arsenal Research, representing the ARC system in Austria
- Fraunhofer Society, Germany

## B.1 SINTEF

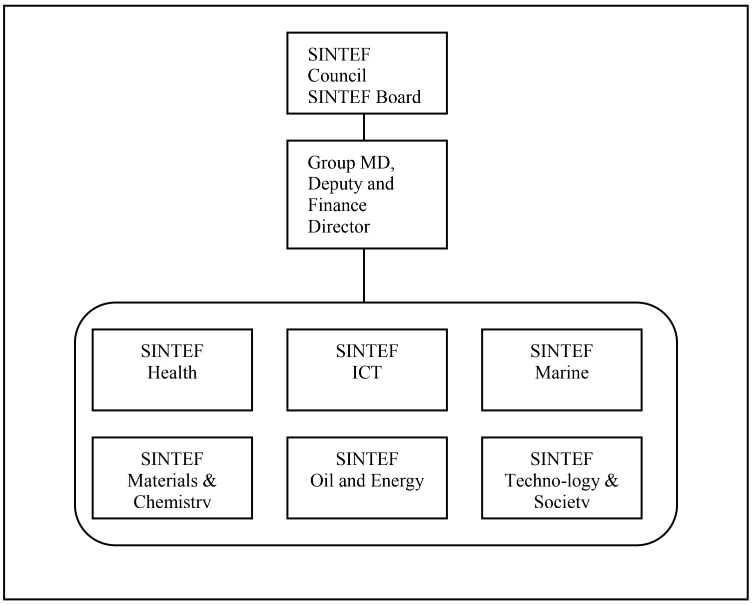
### Composition

SINTEF is the largest Norwegian research institute, and its headquarters is located on the campus of the Norwegian University of Technology (NTNU). It has two goals

- Promote technological and other industrially-orientated research at NTNU, and develop cooperation between NTNU and the nation's industry and commerce, other research organisations and academic institutions
- SINTEF shall meet the needs for research and development in the private and public sector

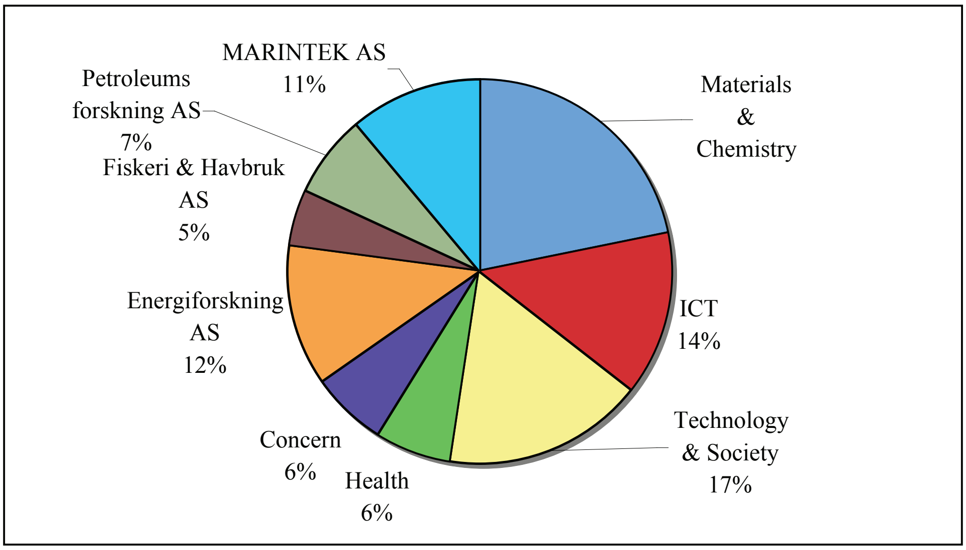
Its 2004 organisation is shown in Exhibit 50. Within the individual divisions, organisation is primarily by technical discipline, matching the organisation of the University. SINTEF describes itself as a polytechnic institute, reflecting its breadth of scope. From being made up of many small, specialised groups, it simplified its organisation into 12 bocks, and reduced their number again to 6 in the early 2000s, arguing that customers wanted increasingly wide-ranging solutions and services. Its reporting is complicated by the fact that some of the larger institutes brought into the group in recent years are not wholly owned, so it tends to report figures both for the SINTEF foundation and for the larger concern, including these subsidiary companies.

**Exhibit 50 Organisation of the SINTEF Group**




SINTEF's operating income is divided among different parts of the concern as shown in Exhibit 51. The pattern strongly reflects SINTEF's role in the Norwegian economy, straddling resource development and use, process industry and ICT. As in Norwegian research more widely, molecular biology is not a major focus.

**Exhibit 51 SINTEF Turnover by Institutes and Subsidiaries, 2004**




In 2004, the SINTEF group employed a total of 1810 people, and the Foundation 1114 (Exhibit 52). At the group level employment numbers have been quite volatile; they are more stable within the Foundation. Operating profitability is close to zero, compared with the 3% or so return on sales targeted by the Research Council of Norway for the industrial institutes.

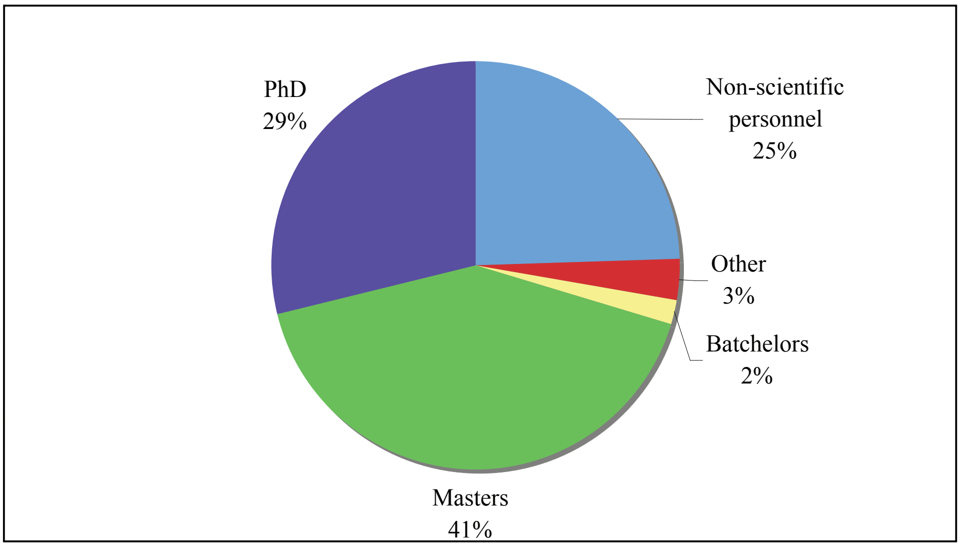
**Exhibit 52 SINTEF Employment, Turnover and Operating Profitability 2000-4**

| | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| **SINTEF Foundation** | | | | | |
| Turnover (MNOK) | 1029 | 1034 | 1084 | 1109 | 1075 |
| Employment | 1136 | 1135 | 1162 | 1118 | 1114 |
| Operating result (MNOK) | 19 | 24 | -5 | 14 | -27 |
| Turnover/employee (MNOK) | 0.91 | 0.91 | 0.93 | 0.99 | 0.96 |
| **SINTEF Group** | | | | | |
| Turnover (MNOK) | 1547 | 1651 | 1618 | 1690 | 1692 |
| Employment | 1852 | 1929 | 1770 | 1758 | 1810 |
| Operating result (MNOK) | 41 | 54 | -25 | 24 | -30 |
| Turnover/employee (MNOK) | 0.84 | 0.86 | 0.91 | 0.96 | 0.93 |

***Source***: *SINTEF*

Exhibit 53 indicates that the SINTEF staff is very highly qualified, with an unusually high level of PhD employment.

**Exhibit 53 Qualification Levels of SINTEF Staff, 2004**




## History

Higher education in Norway is only a couple of centuries old. The University of Oslo (UiO) was founded in 1811 in what was then the capital, Christiania, after a long campaign to persuade the Danish rulers that it was not adequate for the University of Copenhagen to serve as a national university for Norway. *Norges Landbrukshøyskole* (at Ås, outside Oslo) was set up in 1859 but extended its activities from teaching to research only in 1897. Only in 1910 was a national polytechnic (*Norges Tekniske Høyskole*) set up in Trondheim. In 1996 it was merged with the much newer University of Trondheim to become NTNU. The university in Bergen was set up in 1948 and that in Tromsø in 1972. As in other European countries, recent years have seen efforts to introduce research capabilities into regional colleges and campaigns by those colleges for university status.

Norwegian higher technical education was small scale and dominated by German models – with most of the senior members of the scientific community being educated in Germany – until after the Second World War. NTH graduated only 19 PhDs in the period 1910-40 and significant expansion had to wait until after 1945. After the War, Norway turned west and reached for more Anglo–American models. Norway began to set up a research council system immediately after the Second World War, as key scientists and engineers returned from abroad, after working in the research part of the war effort.

NTNF, the Norwegian Research Council for Scientific and Industrial research, was established in 1946, linked to the Ministry of Trade and Industry (NHD). In 1946, also, NLVF (Norwegian Research Council for Agriculture) was established, linked to the Ministry of Agriculture (LD). A council for basic research was set up three years later, in 1949: NAVF, the Norwegian Research Council for Science and the Humanities.

The major growth in techno-industrial institutes came after World War II. In 1950, NTNF began setting up various applied technology institutes – notably the Central Institute for Industrial Research (SI), which it owned and funded. In Trondheim, NTH established SINTEF in competition with the Oslo-based activities. There was a rapid growth in institutes for applied social science in the 1960s and 1970s. Until the mid-1980s, these institutes were generally ‘owned’ directly by ministries or by ministries’ own research councils. In the mid-1980s, however, as part of an international wave of separation between the customers for research and the research performers, NTNF was encouraged to divest itself of its techno-industrial institutes. The techno-industrial institutes became separate foundations.

About a quarter of Norway’s R&D activity is done in the research institute sector – about the same proportion as is undertaken in the university and college sector. Research institutes in Norway perform a proportion of total R&D, which is higher than in most other countries.[42]

[42] There are no reliable international figures that allow comparison of different countries’ R&D expenditures through research institutes. Research institute spending is an unidentified component of government research outside the higher education sector, in the OECD statistics, so it is mixed up with various other kinds of government R&D expenditure, including defence. A study of eight OECD countries based on 1987 data found

Emblem et al[43] explain the extraordinary importance of institutes in the Norwegian research and innovation infrastructure in terms of

- Weak industrial R&D capability, which meant that the techno-industrial institutes could to a degree perform R&D **on behalf of** industry, especially since their focus was on **applied** research
- The multi-disciplinary capabilities of the institutes, which unlike the universities were able to tackle users' **problems**
- The sector principle, where research is seen as one policy instrument among others and where institutes associated with ministries are used as 'insiders' in policy development

Strikingly, the Norwegian industrial institutes tend to have been set up on the initiative of the state, rather than building on trade or industrial research associations.

Having been established in 1950 by the Norwegian University of Technology (NTH), SINTEF grew for the first 35 years of its life organically, with professors at the University setting up research departments within SINTEF, which they themselves led. The 1970s saw rapid growth, fuelled by the need for technology in the booming oil industry and agreements that tied access to oil concessions to sponsoring Norwegian research. In 1980, SINTEF's legal form was changed to the current foundation and it began to be run by full-time research managers rather than the NTH professors, many of whom nonetheless kept positions in both organisations. In the mid-1980s, additional institutes were merged into SINTEF, which then took on the form of a concern. SINTEF took over SI in 1993 – so that the greatest part of the Norwegian industrial research institute effort was centralised to a single organisation. This also meant that SINTEF took over SI's relationships with the University of Oslo. Exhibit 54 tracks this history via the number of people employed at SINTEF over time.

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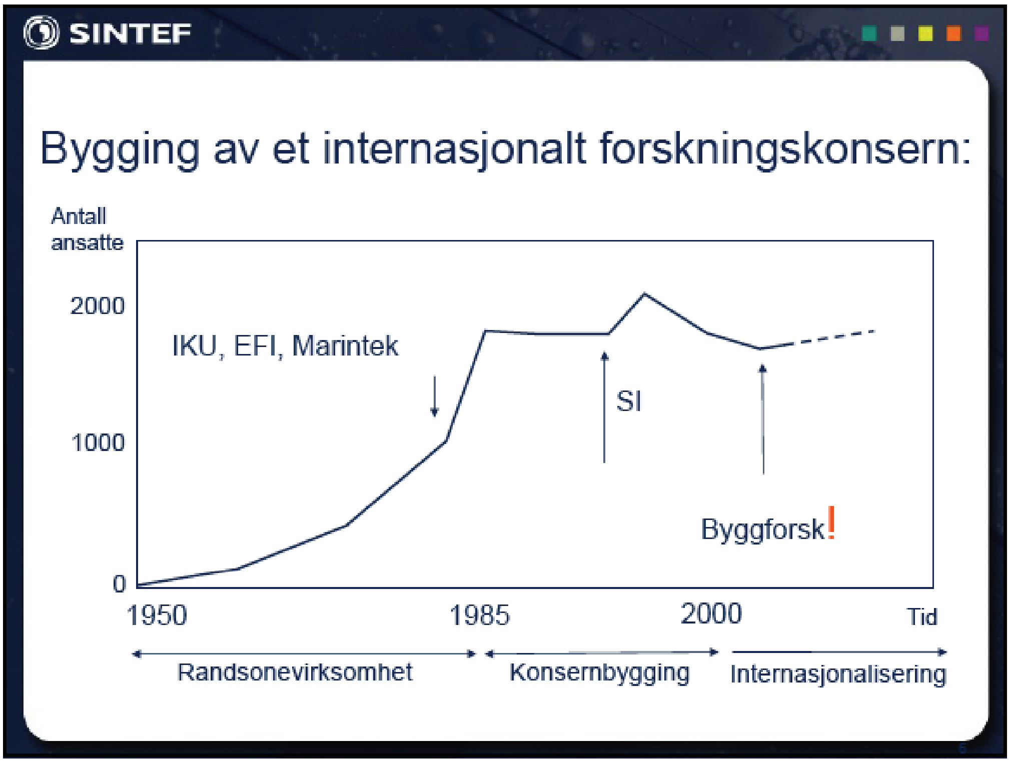
that only Italy spent a greater part than Norway of its national R&D investment in the institutes. See Ole Wiig, *Forsknings og utviklingsarbeid i Norge og andre OECD-land*, 7/90, Oslo: NIFU, 1990

[43] Terje Emblem, *Strategi for instituttsektoren. Mål, struktur, organisering,* Rapport nr 3 fra prosjekt om instituttpolitikk i Norges Forskningsråd, Oslo: NFR, 1995

**Exhibit 54 Growth of Employment at SINTEF over Time**




Some of the reduction in staff during the latter 1990s was caused by rationalisation in the administration. This was driven in part by synergies with SI but also by the changing character of the workload, so that by 2000 70% of the staff were doing research, and that proportion has since risen.

## Role in the Innovation System

### *What SINTEF Does*

Unlike some of the other institutes considered here, SINTEF has not historically built on the measurement and testing role. Its purpose from the start has been industrial development, doing applied research and development, partly based on a vision that research institutes can deliver usable products and processes to industry. It describes the bulk of its work as 'multi-disciplinary contract research' with "Problems set and solved in the context of application."

Researchers at SINTEF each produce about 0.2 scientific publications in refereed journals per year.

### *Customers*

SINTEF's key role in Norwegian industrial development means that it has long relationships with many of the major Norwegian companies, such as the Hydro group. Another large block of industrial demand comes from medium-sized firms, benefiting from the Research Council's 'user-directed R&D' programmes. Here, the Council funds up to 40% of the costs of R&D projects provided they are partly performed in the research and higher education sector. (This is shown as industrial income in the SINTEF figures) Since 2003, the SKATTEFUNN R&D tax concession – which is capped, so that the majority of the tax foregone is available to smaller companies – has provided a further incentive for firms to use SINTEF and the other institutes. Unfortunately, there appears to be no analysis available of how the industrial income divides among different types of customer.

The EU Framework Programmes have been worth up to 50 MNOK per year to SINTEF. The Research Council co-finances EU projects, so SINTEF does not suffer the constraint found in many other places that there is too little core funding to allow Framework Programme participation. However, SINTEF nonetheless turns down many invitations to join EU project proposals, focusing on those that complement existing activities and plans.

SINTEF now has outposts in Houston and Warsaw but has yet to develop an internationalisation strategy. 60% of SINTEF's foreign sales are outside the EU, so such a strategy would need to be global – especially as almost all the EU sales come from the EU Framework Programmes.

A fairly recent development has been to build longer-term strategic alliances with key customers on a formal basis. For example, SINTEF signed a 50MNOK agreement with Sydkraft establishing a working relationship for the period 2002-6. There are 9-year agreements with two oil companies about flow assurance in oil pipelines.

The institute operates with account managers for the largest 10-15 industrial customers. They sit in the relevant institutes, not centrally, but have responsibility for coordinating relations with the customer across the SINTEF group.

Sales and marketing are done at almost all levels in SINTEF. The institute prioritises the need for individual researchers to be proactive in generating business.

#### *Relations with the University Sector*

SINTEF's origins and history mean that its relationship with NTH/NTNU has been symbiotic since it was founded. In 2003, 537 of SINTEF's employees held some sort of post at NTNU, in addition to their SINTEF duties. Especially in Trondheim, many facilities are shared between the University and SINTEF. In 2003, SINTEF estimated that it and NTNU both invested of the order of 30 MNOK in shared equipment and running costs for the year.

During 2004, there were 89 PhD students with external grants placed at SINTEF for their studies. In addition, 32 members of SINTEF staff were working for their doctorates, making a total of 121 PhDs in progress. In total, 109 SINTEF staff were acting as PhD supervisors.

There is not routinely an arms-length accounting for this or for the work done by the one organisation that benefits the other, such as the alignment between university research and the development of technology platforms by SINTEF. Clearly, however, the relationship provides very large synergies and is highly valued by both sides.

A reason why the relationship has been difficult to account for in the past has been its bottom-up character. In 2005, the Boards of NTNU and SINTEF for the first time decided to establish a common strategy. Both Boards decided[44]

- TNU and SINTEF have ambitions to be outstanding in the international arena. They agree that the best way to achieve this is together and to devise a long term, binding strategy
- A common strategy will be developed at institutional level that will cover internationalisation, main disciplinary priorities, research and commercial policies, building brands and investing in and operating large scientific equipment and physical infrastructure, including buildings
- NTNU and SINTEF regard it as right to establish national strategies and alliances in a range of areas. SINTEF's work to establish closer relations with the University of Oslo is an important part of this effort
- A committee comprising three members of top management from each institution, including the rector and the group managing director, will manage the alliance. The committee will propose common strategies and have these approved by the respective institutions and their Boards. The chair of the committee will alternate between the institutions
- The Boards of NTNU and SINTEF will meet together every 6 months to approve common strategies and potentially to agree other measures of common interest
- The leaders of the institutions are responsible for the implementation of common strategies and their organisational and financial aspects within their respective institutions

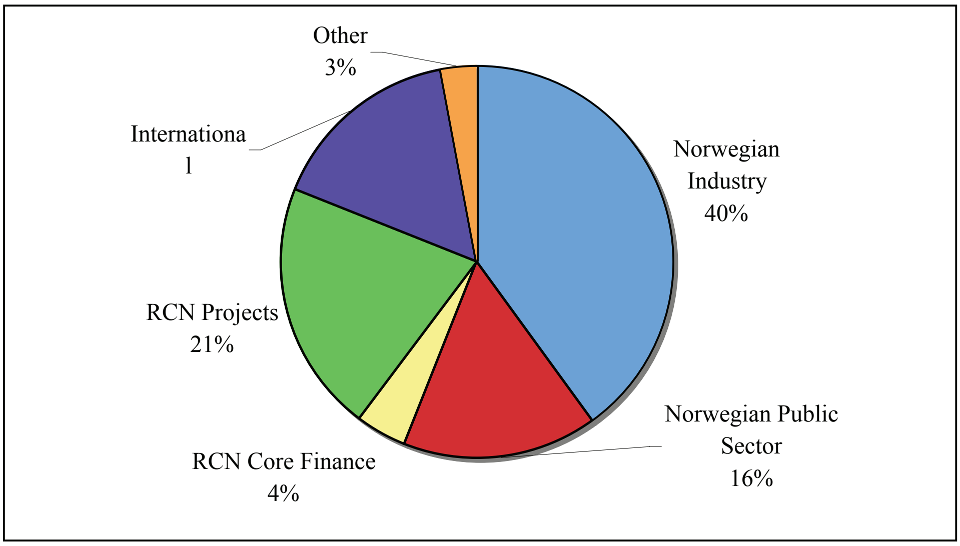
### Financing and Resources

Exhibit 55 shows SINTEF's group income in 2004. The core finance includes some 30 MNOK of 'Strategic Institute Programme' financing, which is bid competitively among the research institutes in Norway, and

[44] Board decisions of NTNU and SINTEF, 8 February 2005

which is intended to allow them to develop new areas of knowledge. There is widespread agreement among the Norwegian institutes that these funds are too small – both in total and in terms of the individual project sizes, which are generally enough to fund one PhD – to be significant contributions to developing capabilities. In 2004, SINTEF received a little more than an additional 40 MNOK in general (basic) funding.

**Exhibit 55 SINTEF Group Income by Source, 2004**




What these numbers do not capture is the contribution of NTNU (and more recently the University of Oslo) to developing knowledge and capabilities at SINTEF. With over 500 personnel engaged partly in university activities, SINTEF in practice has a significant invisible 'R&D department' – comprising about 100 PhD students, among others (see next section).

The SINTEF Foundation had shareholders' funds of 735 MNOK in 2004, equal to 58% of its balance sheet and 68% of its turnover for the year, reflecting the institute's strong financial position.

### IPR

SINTEF claims to have spun off about 100 companies over the past 20 years, which together employ about 2000 people. The current development plan sets a target of 15 spin-offs per year.

Sinvent – a company within the SINTEF group – helps establish spin-offs, holds shares in spin-offs on behalf of the group, manages the patent portfolio and commercialises IPR through licensing as well as spin-offs. Where SINTEF takes shares in start-up, it typically aims to dispose of shares at the Initial Public Offering stage. It set up a venture fund in 2002 together with a package of measures intended to support potential entrepreneurs within the organisation through the innovation process.

SINTEF devotes a fair amount of internal training and publicity effort to developing an 'IPR-aware' culture. This includes promoting the idea that industrial activity and spin-off is a rewarding and high-status activity. There are also training courses on management, run by SINTEF people.

#### Management, Strategy and Future Perspectives

SINTEF operates in a rather decentralised way, with finance and overall strategy being among the main issues tackled centrally. Historically, SINTEF has been an important component in Norway's post-War industrial development and it continues to see a role for itself in 'nation building'.

SINTEF sees the main drivers for change as

- Globalisation
- Development of new technologies
- Symbiosis of fundamental and applied research
- Sustainable development
- Transition of Norway to a knowledge economy

From SINTEF's perspective, therefore, it has a major role to play also in the next stage of economic development. Its main goals in the current development plan (2003-6) are

- Technology for a better society
  - SINTEF will be a driver in restructuring and the development of Norwegian society
- More satisfied customers
  - Improved marketing and customer satisfaction
  - SINTEF will grow both nationally and internationally
  - We will lead in the field of innovation and commercialisation of research results
  - The SINTEF brand will be well known
- Disciplinary quality
  - We will raise the quality of our disciplines and establish leadership in some
  - We will be a preferred cooperation partner for NTNU and the University of Oslo
- Attractive employer
  - The company culture will be founded on our four values of honesty, generosity, courage and unity
  - We will strengthen the business culture within SINTEF
- Economic independence of action
  - We will have a robust financial performance that gives us the freedom to develop ourselves and enable us to preserve our corporate values

SINTEF expects in future to increase the number of university and institute relationships it has abroad. (Sweden may be especially interesting, given the country's greater strength in manufacturing than Norway's.) NTNU, like other universities, is having increasingly o specialise in order to be internationally competitive. This forces SINTEF to look more widely for relationships in more fundamental research areas.

Large internal effort has gone into specifying the processes used in SINTEF, documenting them, identifying best practices and training around these, for example in project management. One focus has been to reduce the extent of over-delivery on projects, where researchers provide more than the client pays for. SINTEF believes a culture of over-delivery has been one of the reasons why projects over-run their budgets, hence this action is expected to have an important impact on profitability.

Increased regionalisation in Norwegian policy means that SINTEF needs more regional representation. It has therefore opened offices in Bergen, Stavanger, Møre and Raufoss and has further extended its presence in Oslo.

## B.2 The GTS Institutes

### Composition

The GTS institutes – Godkendte Teknologiske Serviceinstitutter or Authorised Technological Service Institutes – are a group of independent not-for profit and mainly self-owning institutions. Their role is "to deliver on a market basis solutions to tackle capability failures that may arise in companies in connection with innovation."[45] According to Christensen et al, their closest 'relatives' in the innovation system are consultants, consulting engineers, advertising bureaux, etc, and their role has to be understood as part of a Danish policy focus on technology diffusion, as opposed to technology push through the creation of new technology platforms.[46]

[45] Erhvervsfremme Styrelsen, *Teknologisk service Redegørelse 1995*, Copenhagen: Erhvervsfremme Styrelsen, Erhvervsministeriet, 26 January 1996

[46] Jens Frøslev Christensen, Pauline Tue Christensen, Kirsten Foss and Peter Lotz, Teknologisk service: Tendenser og udfordringer. En diskussion af GTS-institutternes værdi for Danmark, Hørsholm: Institutrådet, 1996

**Exhibit 56 GTS Institutes' Turnover and Employment, 2005**

| | Turnover (MDKK) | Employees | Turnover/Employee (MDKK) |
|---|---|---|---|
| Bioneer (Biotech) | 30 | 35 | 0.86 |
| DBI (Fire) | 79.8 | 100 | 0.80 |
| DFM (Metrology) | 18.3 | 18 | 1.02 |
| DHI (Hydrology) | 382.3 | 514 | 0.74 |
| DTC (Toxicology) | 27 | 44 | 0.61 |
| DELTA (Electronics etc) | 210.9 | 235 | 0.90 |
| Dansk Standard | 156.9 | 198 | 0.79 |
| FORCE (Production) | 716.9 | 912 | 0.79 |
| DTI | 714.3 | 825 | 0.87 |
| Total GTS | 2336.4 | 2881 | 0.81 |

According to GTS today, 49% the employees are 'academically' educated, ie they have a higher degree and 8% of the staff hold at least a PhD. In the late 1990s, the GTS system produced about 250 scientific articles per year (about one-fifth of an article per employee per year).[47] This production appears to have fallen significantly, with only 92 articles appearing in 2005.[48]

No figures are available, but the GTS institutes have a low rate of labour turnover compared with both industry and the universities. Wages were said to be above university levels but below those paid by technical consulting firms.

GTS institutes have started to establish themselves abroad as part of a strategy both to extend their markets and to gather knowledge from abroad. For example, both FORCE and DTI have offices in Sweden.

## History

The current set of GTS Institutes has its origins in three former groups

- DTI and its predecessors
- The ATV (*Akademiet for de Tekniske Videnskaber* – Academy of Technical Sciences) institutes
- Other institutes

Teknologisk Institut (TI) was set up in 1906, primarily as a teaching organisation providing training and further education in technological subjects as well as various technical services, and a competing school (Jysk

[47] *GTS-instituttternes rolle i Forsknings- og utdannelsessystemet*, Hørsholm: GTS-Institutrådet, 1998

[48] GTS Performanceregnskab 2005, GTS.

Teknologisk Institut) was founded in Jutland in 1943. The two organisations merged in 1990 to form Dansk Teknologisk Institut (DTI).

TI was financed wholly by trade and research associations, and while the state played an increasing role in financing TI (and JTI) in the post-War period, in 1995 about a quarter of DTI's income still came from 90 member organisations. Education and training have gradually been transferred to other parts of the state system, so that DTI and its predecessors have increasingly focused on the RI role over the past decades. Partly as a result of reducing state subvention but also because of changes in the social role of the institutes, DTI experience severe financial difficulties in its early years. Its staff numbered 1242 at the beginning of 1994. This was cut by 14% during the year, and the institute was restructured into a smaller number of thematic divisions, largely abandoning the previously branch-oriented structure. Several activities were transferred to other organisations.

While DTI has its roots in the collective needs of certain Danish branches, the ATV institutes reflect the desire of the independent Academy of Technical Sciences (ATV) to build technology push institutions and to establish industry-relevant research at Denmarks School of Technical Science (DTH) which was originally a teaching institution. Rector P.O Pedersen of DTH (now DTU), who was a founding father of ATV in 1937, explicitly aimed to kill two birds with one stone. Industry and foundations should pay for equipment and researchers at DTH, which would satisfy the college's need to do research and at the same time generate results for transfer to industry. The resulting institutes in areas like welding, electronics, hydrology and corrosion were more technology- than branch-oriented, reflecting their 'technology push' character and were collocated with DTH.

The third group of institutes has mixed origins – though in some cases ATV helped establish them. They are more oriented to social needs such as, fire, metrology, testing and standardisation . The metrology institute is the most recently established one in the GTS network, having been set up in 1985 and the only GTS institute set up by government initiative. There have been discussions about whether to establish an institute in the 'new economy' but these have not led to anything new being set up although a small GTS institute of Design did exist for some years around 1990. In 2006, the Danish Government initiated a semi-open call for parties interested in assuming GTS status. Six institutes were pre-qualified, including one focusing on new economy business and three being extensions of existing universities. A number of those candidates is expected to be given GTS-status by 2007.

Christensen et al argue that the GTS institutes therefore comprise a mixture of technology-push organisations with others that originally focused more on collective needs for education, training, testing, standardisation and other services. The role of state financing in the institutes' turnover rose from nil in 1940 to somewhere between one half and two thirds by the early 1970s. This core financing fell in both absolute and relative terms from the mid-1970s, declining to 20% by 1988 and to 12% by 1994, a level that has remained roughly constant until today (10,5%). Driven by these changes in finance, the roles of the institutes have tended to converge on technological services, with education and training passing to other parts of the system and – in the case of the ATV institutes – reducing links to fundamental research in the higher education sector.

At the highest point, there were 46 institutes in the system but these have been rationalised down to 7. While the mergers of the 1980s were policy driven, those in the 1990s and later are mostly said to be driven by market needs and opportunities, such as strong overlaps among the customer bases of different institutes. To the outside observer it seems fully conceivable that the entire GTS system may eventually be folded into DTI, which is a disproportionately large and broad member of the GTS network.

The GTS system itself was established under the 1973 Law on technological service. A Council for Technological Service, whose form has been simplified over time, has overseen the network. Evaluation has been introduced, and a system of performance contracts has been established between the Industry Ministry and the institutes, at the same time as the state's contribution to their financing has been falling. Since 1995, all GTS institutes have collaborated within their own trade organisation, GTS – Advanced Technology Group (GTS).

## Role in the Innovation System

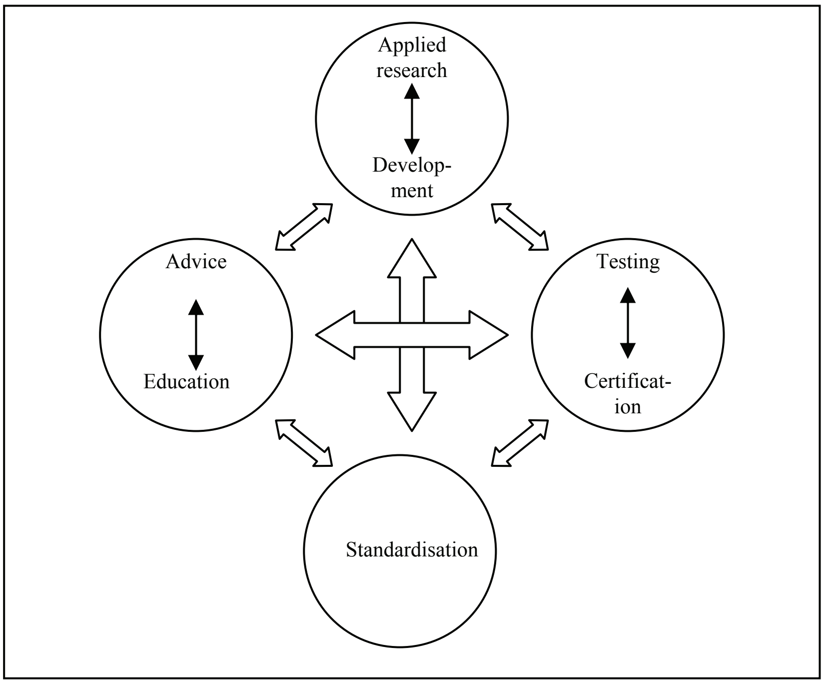
### *What GTS Does*

"We tend to look at ourselves more as the craftsmen of innovation than as researchers." While some institutes are more research-oriented than others, GTS describes itself as primarily concerned with the adaptation and implementation of existing knowledge. Broadly, the GTS institutes appear to do about 80% of their work in response to customer demands, focusing on existing knowledge, while about a quarter to a fifth involves R&D.[49] The institutes do not inspire their customers to innovate – they help them implement their innovation intentions.

[49] *GTS-institutterne som videnleverandører*, GTS-Institutrådet, Hørsholm, 2000

Christensen et al say they had difficulty in creating a complete list of activities in the GTS institutes and in organising the list when it had been made, owing to the self-organising nature of the activities and the extent to which they were not subject to much reflection. They evolved what they called the 'circular' model, to illustrate GTS' role in innovation. They contrast this with some institute systems in larger countries, which they see as essentially doing 'technology push' in support of a linear innovation model, while the GTS institutes work with a model of 'collective needs' resulting in demand pull.

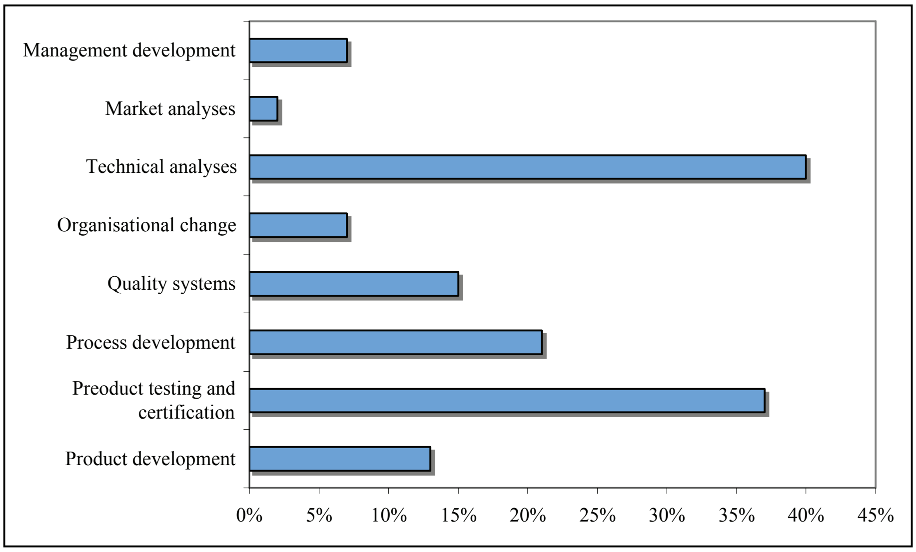
**Exhibit 57 The Circular Model: Inter-relationships among Key GTS Activities**




***Source*** *Christensen et al, 1996*

Exhibit 58 reports the results of a survey of GTS projects, and shows that standardisation and testing are in fact the dominant activities. (The percentages add up to more than 100%, as projects can have multiple activities.)

**Exhibit 58 Activities Involved In GTS Projects, 1999**




***Source**: Bjerregaard and Nielsen*

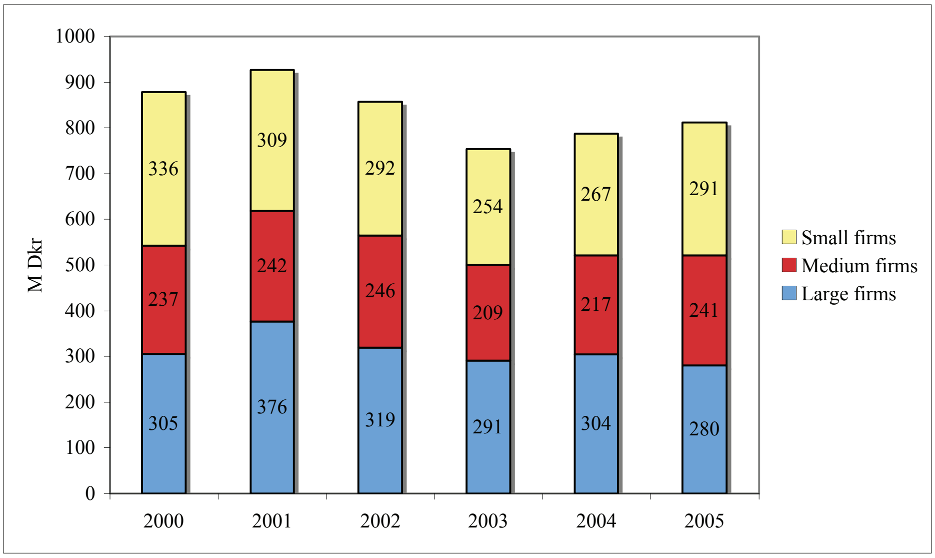
***Customers***

Denmark is very much an SME economy. In 2005, GTS institutes undertook assignments for about 31 000 companies, down from 36 000 in 2000. A 1999 survey showed that some 72% of firms in manufacturing had used GTS within the previous two years, while in other branches the proportion was about half.[50] According to a similar 2006 survey, this proportion has fallen to "only" 53% but in the same period, non-manufacturing enterprises sectors' use of GTS have risen dramatically. 37% of GTS domestic commercial turnover is generated from service enterprises[51]. According to the 2006 survey, 95% of users say they are "very likely" or "likely" to consult a GTS institute again and the 1997 survey suggested that 92% of large firms and 87% of small and medium-sized firms using GTS services did indeed come back and buy more within 2 years.

[50] GTS-Institutrådet, 2000

[51] Oxford Research A/S and GTS Performanceregnskab 2005.

**Exhibit 59 GTS Private Commercial Revenues in Denmark by Size of Firm 2000-5**




***Source**: GTS Performanceregnskab, 2004 and 2005*

Recent Community Innovation Survey results suggest a polarisation among Danish manufacturing companies (Exhibit 60), with a growing proportion not making product innovations and a smaller group being ever more innovation-intensive. This suggests (a) that the innovative portion of the firm population is declining and (b) that the importance of traditional GTS-style services may be decreasing. However, growth in non-manufacturing and high-tech manufacturing services has outweighed this decline. The figures do not, however, suggest that the universities' role is in any way increasing – rather the reverse.

**Exhibit 60 Companies' Interaction with the Knowledge Infrastructure, 1997-2004**

| | 1997 | 2004 |
|---|---|---|
| Cooperating with GTS and Universities | 5.8% | 6.1% |
| Cooperating with GTS only | 16.4% | 10.3% |
| Cooperating with Universities only | 3% | 1.5% |
| No cooperation with the Knowledge Infrastructure | 26.8% | 24.9% |
| No product innovation | 48% | 57.2% |

***Source**: Innovation og vidensamspil i fremstillingsindustrien, Hørsholm: GTS, Januar 2005*

### *Relations with the University Sector*

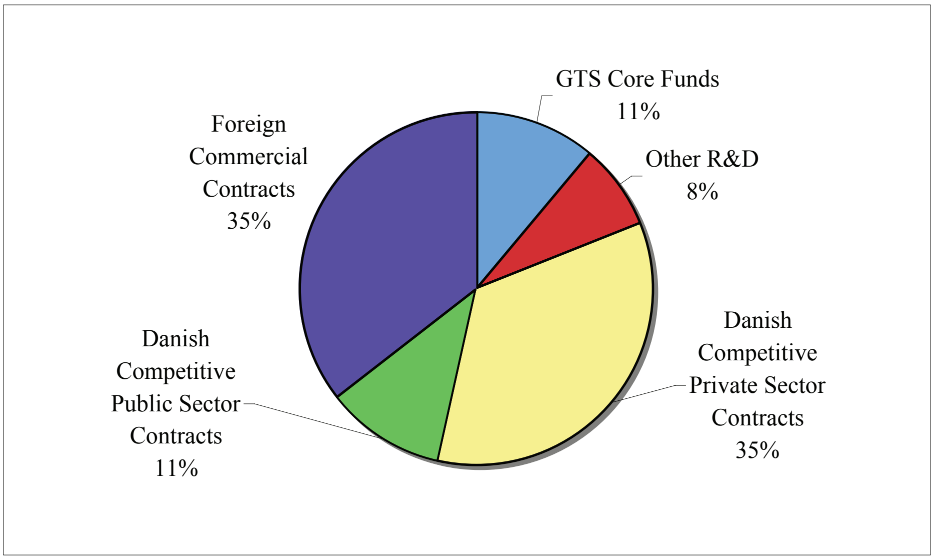
While GTS still likes to describe itself as a 'bridge' between academic and industrial research, reductions in GTS' R&D budget over time mean that there are few strategic links to the university system. Out of 206 active collaboration projects in 2005 between GTS and Danish universities, 116 were formalised.[52] In many areas, GTS sees technological development as rather autonomous from more fundamental research, so that there is limited need for such interaction. It is able to provide 'science watch' services to its customers without help from the universities.

GTS signed a cooperation agreement with DTU in 2004, to re-establish its historical link with the University (formerly DTH). While the relevant documentation refers to 200 instances of cooperation in the years leading up to this agreement (not least in relation to centre contacts), there is little substantial analysis and the document devotes a great deal of effort to explaining the difficulties involved in cooperation between the different cultures and financing systems present in the University and Institute systems. Strategic-level contacts were established with the Technical University of Aalborg only in 2003. A very small number of PhD students make use of GTS facilities as bases for their studies.

#### *Financing and Revenues*

The Ministry of Science, Technology and Innovation (VTU) provides core funding for GTS on the basis of an annual **performance contract**. Core funding via these contracts accounted for about 10% of turnover in 2004 (and will account for about the same in 2005). In total, GTS describes a fifth of its turnover as 'R&D' (compared with one quarter in 2000) and the balance as commercial income: about one third each from business based in Denmark and abroad; the balance via contracts won in competition from the Danish state (Exhibit 61).

**Exhibit 61 GTS Network's Revenues, 2005**

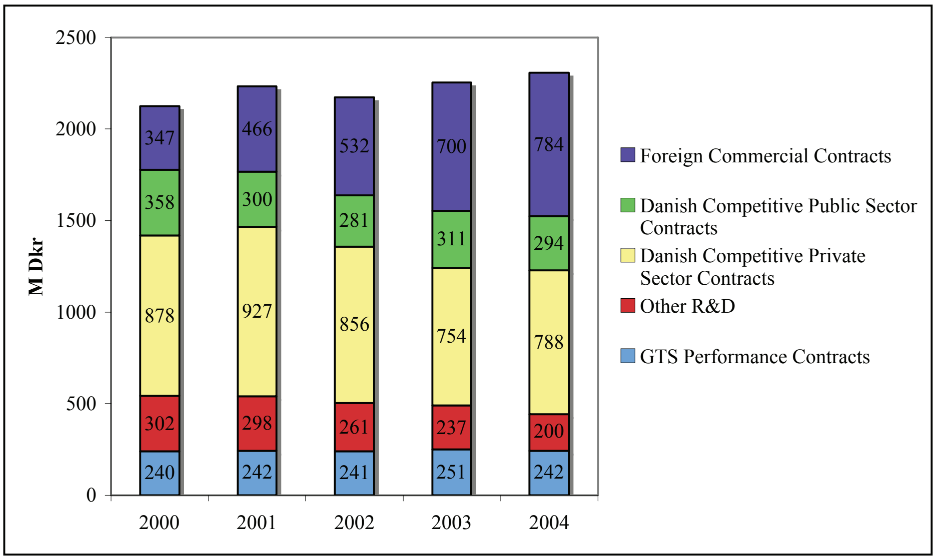



***Source****: GTS Performanceregnskab, 2005*

[52] *GTS Performanceregnskab 2005*, GTS.

Exhibit 62 shows that the foreign income has grown dramatically in recent years – doubling since 2000 – a development that GTS explains as not only representative of increasing globalisation but as confirming the idea that an increasing part of Danish-based industry is becoming less innovative and that medium-sized manufacturing firms are moving production out of the country.

**Exhibit 62 GTS Network's Revenues, 2000-4**




***Source**: GTS Performanceregnskab, 2004*

Exhibit 62 tends to understate the amount of R&D performed in the GTS system, however, because the institutes themselves finance R&D out of income. Thus, in 2004, they performed a further M Dkr 122 in R&D in addition to the M Dkr 442 shown in Exhibit , making a total of M Dkr 564, or 24% of revenues.

Part of the activity shown as 'Other R&D' in Exhibit  is income from 'centre contracts' or 'innovation consortia', which represented a minor adaptation of the centre contract formula to tackle larger networks of companies, institutes and universities. Centre contracts were designed as a mechanism for bringing together R&D needs of a group of companies with the research capabilities of a university in order to generate both usable R&D results and re-usable intellectual capital for the GTS institutes. These institutes would then exploit this intellectual capital in order to provide Technological Service to other, generally non-R&D-performing companies, thereby generating social returns (externalities).

An evaluation in 2005 of the Innovation Consortium Programme[53] was broadly positive. It confirmed the role of the consortia in developing capabilities at the GTS institutes that could be exploited, with participating institutes expecting future annual sales of the order of 2 M Dkr per contract, though it pointed out that the policy ambition to involve small firms in this kind of project was not effective. It also underlined that this mechanism for generating new knowledge was relevant to existing company networks, but not to new clusters or industries.

### IPR

Owing to its social role and its role in the innovation system, GTS claims to be less concerned with IPR, including patents, than others, especially people in the university system. It was granted a total of 15 patents in 2005, a level typical of performance in the previous five years. The rules under which GTS operates give its customers exclusive rights to foreground intellectual property within the branch where they operate, while GTS itself may use the IPR in other fields. In the past, there has been little interest in patenting by GTS institutes. This is now growing, however, as the 'rules of the game' change in branches such as biotechnology and parts of electronics. In 2005, GTS institutes spun out two high-tech start-up's based on own research and assisted customers with additional three science-based spin-off's.

### Management, Strategy and Future Perspectives

Since 1995, all GTS institutes have collaborated within a small umbrella organisation, GTS – Advanced Technology Group (GTS). Its Board comprises the directors of the GTS institutes and it has a four-person secretariat. During the past five years, this umbrella has provided a way to focus institutes' strategies, reducing overlaps, and established an Internet portal and functioned as a way to lobby on behalf of the institutes, both to the government and to the outside world more generally.

The idea of performance contracting is now deeply established in Danish public management. While the political climate has recently become more favourable to the GTS institutes, it seems unlikely that core funding will rise more than a little. However, GTS expects that additional innovation policy instruments will increase the total amount of resources available for developing capabilities. The Community Innovation Survey suggests that the proportion of Danish companies that innovate has fallen by 9% between

[53] Inside Consulting and Oxford Research, *Evaluation of the Centre Contract/Innovation Consortium Programme*, May 2005

1997 and 2004[54] and GTS expects this to lead to increased focus on technology transfer and services to SMEs.

The Danish Parliament passed a new law in 2004, aiming to increase technology transfer from the research sector to industry, increasing the opportunities for GTS to act as a bridge-builder in this area. GTS itself suggests that the continuing belief in technology- and science-push in an economy that is dominated by small firms with no research capacity is misguided, and that more resources should be devoted to knowledge acquisition (enhancing SME's absorptive capacity), technology diffusion and the re-use of knowledge.[55]

GTS itself sees timing as key to its performance,[56] in the sense that a key benefit GTS brings to companies is **early** access to new knowledge in order to contain time to market, rather than knowledge that is over time unique. While increasing institutes' ability to proactively seek out potential customers and bring them unique advantages has been seen as an important next step for the institutes for several years, management argues that the low share of core funding in total income makes this ambition hard to realise, and that this has forced GTS institutes to become more **reactive**, rather than more proactive.

## B.3 VTT Technical Research Centre of Finland

The successful role of Finnish national investment in R&D as a basis for emerging from the economic crisis of the early 1990s is too well known to need repetition here. Despite having risen to become the top investor in R&D (as a proportion of GDP) in the EU, Finland continues to emphasise investment in R&D as a basis for continued growth. The national vision is very clear about research being integral to innovation and business positions, and not being detached from society.

> *Finland will ensure her success on a global scale by strengthening the knowledge and competence base, investing in high-quality education and research, developing production and corporate structures, enhancing international marketing and business competence, and enhancing innovativeness and the utilisation of knowledge. Finland's research strategy is built on the present strengths and the need to create new ones through systematic and continuous development of knowledge, competence,*

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[54] GTS Årsberetning 2004
[55] *GTS' indspil til Globaliseringsrådet* den 5 januar 2006
[56] GTS-Institutrådet, 2000

*education, research, and innovation. The underlying principle in extensive international co-operation is high quality and relevance.*[57]

A more recent government resolution clarifies that this vision involves further increased state expenditures on R&D and a national strategy for creating and reinforcing internationally competitive science and technology clusters and centres of excellence (under the direction of the National Science and Technology Policy Council). Sector ministries have been instructed to clarify their relationships with their sectoral research institutes and to seek to increase the proportion of their funding that is external.

*The role of the Technical Research Centre of Finland (VTT) in the implementing of innovation policy will be strengthened. VTT will develop its competitiveness and basic competence especially in selected priority areas of major relevance to Finland and in accordance with the national strategy referred to …. The basic financing of selected fields in VTT must be strengthened.*[58]

### Composition

In 2004, VTT had a turnover of €218m and a staff of 2661, and therefore an average turnover per employee of €82k.

The make-up of the staff is shown in Exhibit 63. The overall number has fallen from 2979 in 2000 to 2661 in 2004, as the numbers of technical and administrative support staff have been reduced. The main driver of reduction has been the use of computers in simulation and in administration. The number of scientists at work has been fairly constant over the period.

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[57] Science and Technology Policy Council of Finland, *Internationalisation of Finnish Science and Technology*, policy statement, 12 November 2004
[58] Government resolution on the structural development of the public research system, 7.4.2005

**Exhibit 63 Composition of VTT Staff, 2000-4**

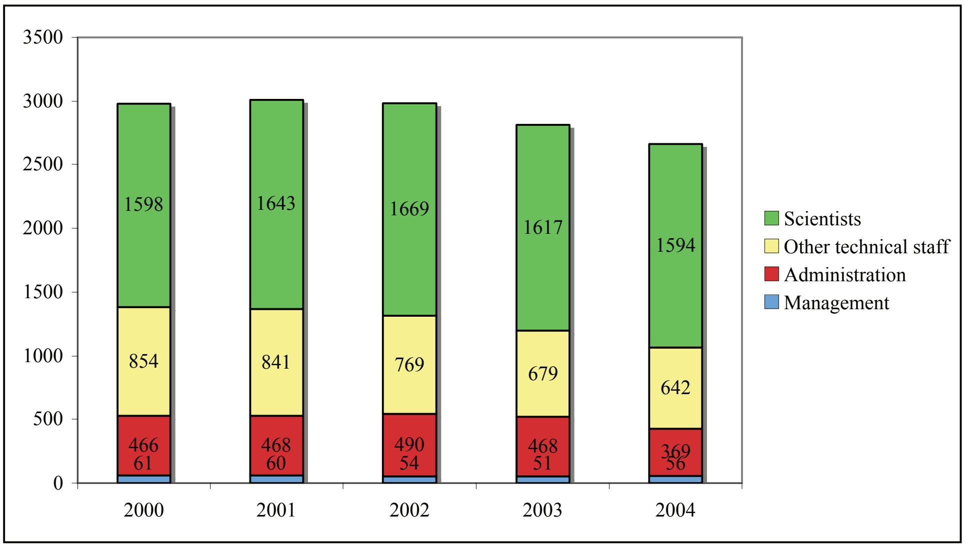
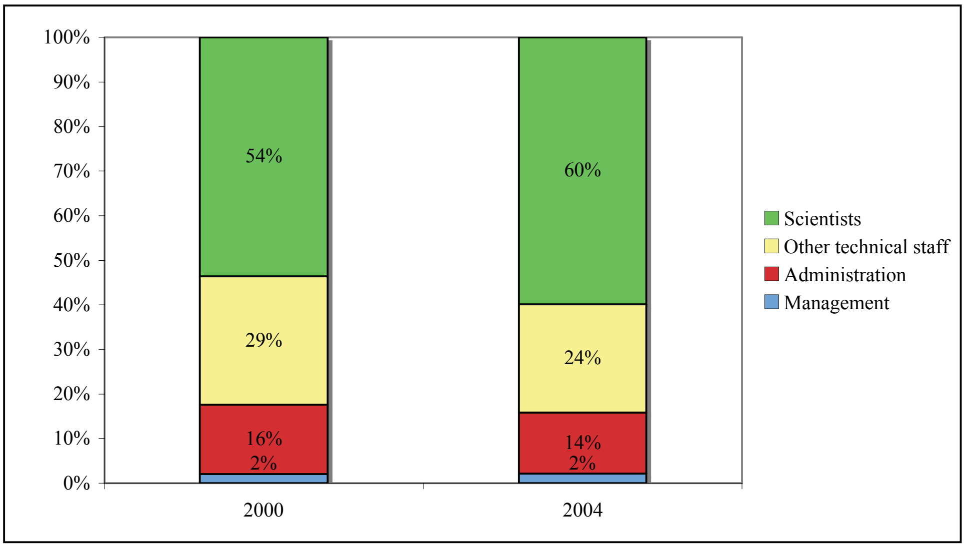



**Exhibit 64 Proportions of Staff in Research and Support Functions, 2000-4**




As a result of a reorganisation in 2005, VTT's structure is complex. No overall organigram is available. The main 'line' structure for R&D is made up of 7 knowledge clusters, sub-divided into 45 'knowledge centres' (Exhibit 65). Administration, services and the new Ventures activity are separately organised.

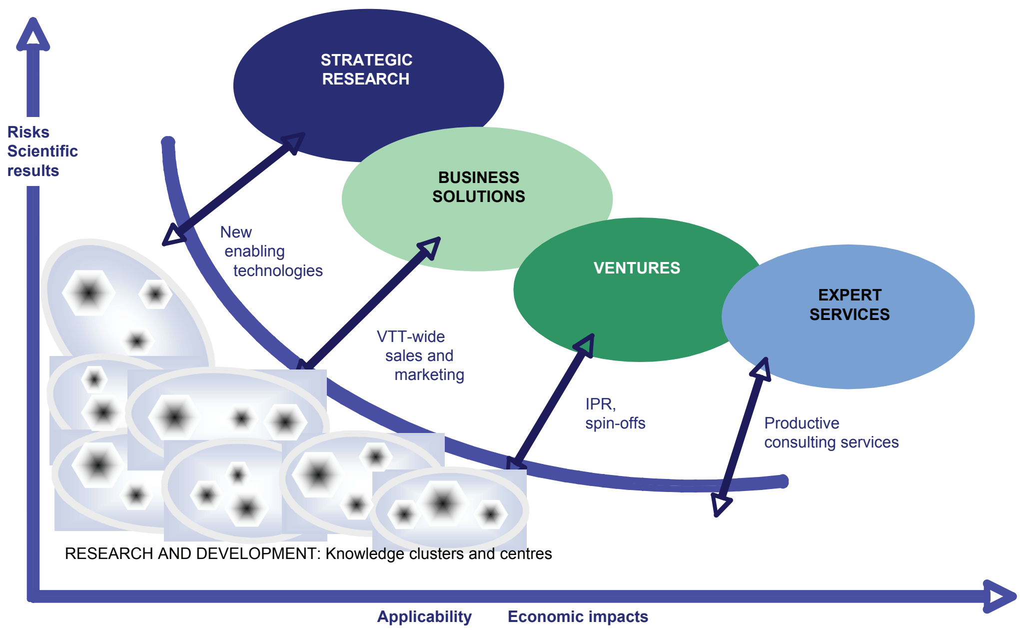
**Exhibit 65 VTT R&D Organisation**

| | Knowledge centres | Full-Time Equivalent Staff |
|---|---|---|
| Digital Information Systems | 6 | 200 |
| Materials and Building | 7 | 330 |
| Telecommunications | 6 | 240 |
| Industrial Systems | 7 | 300 |
| Biotechnology | 5 | 240 |
| Microtechnologies and Sensors | 7 | 230 |
| Energy, Pulp and Paper | 7 | 390 |
| Total | 45 | 1930 |

***Source****: VTT (staff numbers are approximate)*

VTT draws upon this knowledge organisation in order to provide four major activities: strategic research; business solutions; ventures; and expert services (Exhibit 66). Implicit in this is the idea that strategic research builds technology platforms that are then exploited through the other three activities.

**Exhibit 66 VTT Scope of Operations**



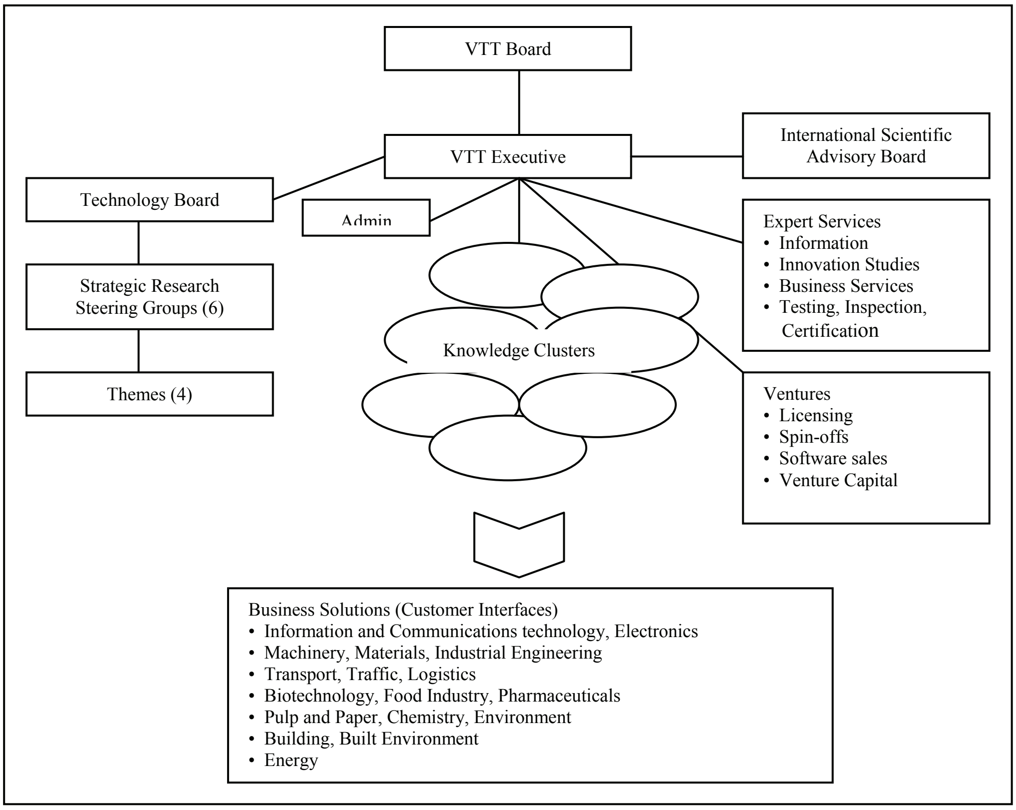

*Source: VTT*

The four activities are to a considerable extent matrixed across the knowledge organisation. In the absence of a formal organigram, we have constructed a diagram that attempts to describe how this is achieved (Exhibit 67). VTT has a Board, similar to a company board of directors, to which the executive management answers. The main 'line' organisation is the knowledge organisation. The organisation of the Strategic Research activities is sketched at the left hand side of Exhibit 67. Strategic Research as a whole is funded from VTT's core grant and from jointly-funded projects (typically with TEKES or the EU) and overseen by a Technology Board, made up of the senior VTT scientists (some of whom hold joint appointments with universities of technology) who chair the strategic research areas and the themes.

There are currently half a dozen Strategic Research areas, each of which has a director and a steering group – all drawn from across the knowledge organisation. Each area comprises 7-10 project portfolios ('technology packages' in VTT terminology), which are related to foresight plans or road maps set out by the steering group. Currently, the strategic research areas are

- ICT
- Technology in the community
- Microtechnologies and electronics
- Applied materials
- Industrial systems management
- Energy
- Bio and chemistry processes

**Exhibit 67 VTT New Organisation, 2005**



In addition, there are four ‘technology themes,’ each with a budget of €4-5m per year, matrixed across the strategic research areas, specifically

- Future telecom technologies
- Service beyond (a new theme for the service sector)
- Intelligent products and systems
- Clean world

The strategic research areas aim to build new enabling technologies, while the themes help draw out applications.

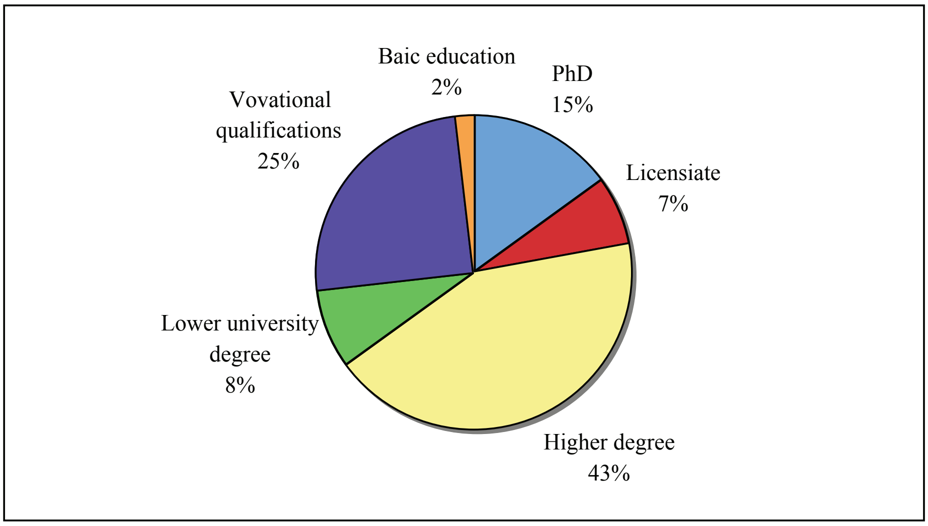
Recently, VTT has added some speculative, high-risk ‘Frontier Technology’ projects, costing about €1m per year.

People within the knowledge clusters also sell Business Solutions projects, but there are seven customer interfaces (indicated at the bottom of Exhibit 67), comprising people who can guide inexperienced customers into the organisation. A separate Expert Services organisation sells the traditional test, certification and measurement services with which VTT started life. The Ventures group is very new. Only in 2005 has new legislation made it possible for VTT to own shares and therefore to set up its own small-scale venture capital activity. These people handle the 2-3 spin-offs a year that VTT has generated of late, as well as licensing and other aspects of IPR.

There is a separate administrative staff for VTT as a whole.

Exhibit 68 shows the qualification profile of VTT. Labour turnover is about 4-5% a year currently (though it was higher during the dot-com boom of the late 1990s). The age profile is ‘mature’ compared with universities (no data available).

**Exhibit 68 VTT Staff Qualification Profile, 2004**




***Source**: VTT Review, 2004*

VTT has established a number of regional laboratories, but not yet moved abroad.

### History[59]

VTT was established in 1942 as an independent research body under the Ministry of Trade and Industry, based on legislation adopted by the Finnish parliament. Originally, it focused on testing for military purposes and for civil defence. Capacity not needed for the war effort was available for civil purposes, but lack of qualified manpower meant that growth was initially slow and that research, as opposed to testing, was little established before the end of the war. VTT experienced little demand for research from private companies until about 1960.

From the beginning the Centre has had the right to negotiate its own contracts for research assignments. During its first three decades, VTT had a very close relationship to the Helsinki University of Technology. Professors often were department managers at the Centre and VTT offered facilities to researchers and students for carrying out research. The Centre was established in large part to test materials and composite structures for the state, private companies and individuals, and initially comprised 10 laboratories. By 1950, there were 15 laboratories and 242 research scientists. VTT moved outside the city to Otaniemi in stages, beginning in 1954. Research began to supplement testing in a significant way from the late 1950s. By the mid-1960s, VTT numbered 400 scientists and was Finland's largest research institute. It had 700 scientists and some 30 laboratories by the 1970s, peaking at 34 during the 1980s, by which time VTT had a total staff of 2500, organised into three major divisions

- Building Technology and Community Development
- Materials and Process technology
- Electrical and Atomic Energy

As a result of an evaluation of VTT by the Ministry of Trade and Industry in 1993, many laboratories were merged to form 9 larger entities, and there was a further reduction to 6 in 2002. However, this resulted in significant internal barriers among the laboratories, each of which was said to function more or less as a research institute independent of the others. Hence, a new evaluation of VTT done in 2004 proposed a reorganisation (since implemented), having identified a number of challenges

- Clarification of VTT's role and mission

[59] Much of this section is based on an English summary, provided by VTT, of Karl-Erik Michelsen, *The State, Technology, Research – VTT and the Development of the National Research System*, Espoo: VTT, 1993 (in Finnish)

- Improved management of the requirements for self-initiated research
- Clarification of goal-setting and operational management
- Systematic networking and internationalisation
- Achievement of innovations based on technological breakthroughs
- An organisation able to respond to new R&D challenges[60]

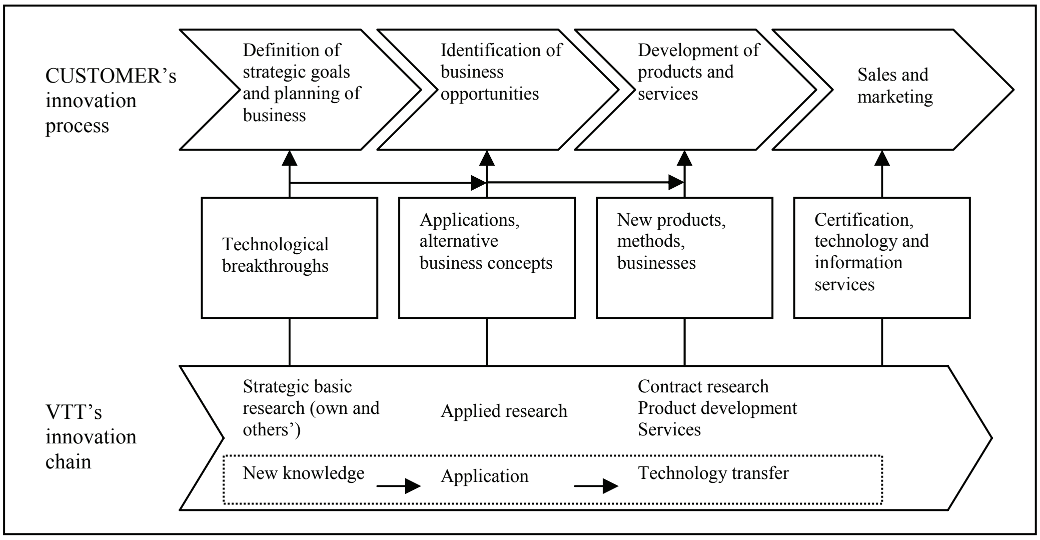
VTT was therefore reorganised during 2005, with some of the work still being in progress in 2006.

### Role in the Innovation System

#### *What VTT Does*

Like most RIs, VTT describes its activities using a linear development model (Exhibit 69). Roughly 30% of the effort is devoted to 'strategic basic' research; 40% to 'applied research'; and the remaining 30% to development and services. VTT intends to increase the proportion of effort devoted to 'strategic basic' research to 40% over time, as its core funding increases.

**Exhibit 69 VTT's Innovation Process**




*Source: VTT*

#### *Customers*

One of the reasons for creating a more centralised organisation at VTT was to be able better to serve the institute's large customers. About 10 'key accounts' are managed by individual account managers within the knowledge organisation. The Exhibit 70 shows VTT's breakdown of its external income by customer group. Domestic income, both public and private, has been stagnant. Income from abroad compensates for this and generates a little growth. EU entry resulted in a surge in international

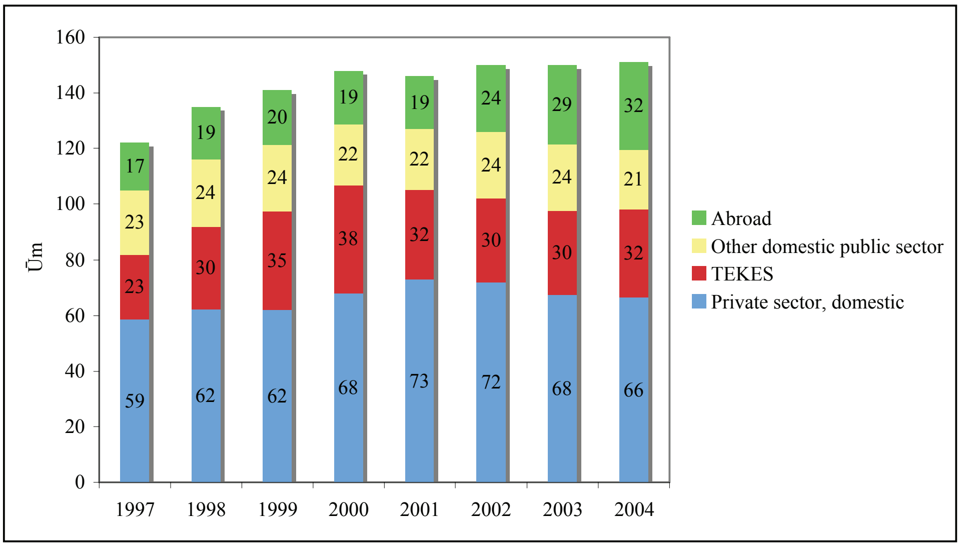
[60] Conclusions of an assessment by Eera Finland Oy, reported in *VTT Review 2004*

projects in 1993, with the number rising from about 150 per year to 550 per year between 1993 and 1998. Since then, growth in international activity has continued at a slower pace.

VTT does not collect data about customer firm size or use any more sophisticated customer segmentation.

Some customer surveys have been undertaken and indicate high levels of satisfaction. The VTT Innovation Studies group has looked at VTT's role in innovation for a sample of customers, and found that VTT played a role in about 20% of their innovations. The importance of VTT as a collaboration partner for these companies has grown since the 1990s, especially in the machinery and electronics sectors. VTT's importance in company innovation was greater among micro-firms with less than 10 employees than among larger companies.

**Exhibit 70 External Income by Customer Sectors**




Antila and Niskanen of VTT Technology Studies examined 219 VTT projects in 2001. They found high additionality

- Half the projects would not have been carried out without VTT help
- 12% of projects would have been done with another organisation
- 6% of projects would have been done in house

This implies that the overlap between VTT's role and that of other organisations (eg universities) is rather limited. The survey also found

- Commercialised innovation in almost half the projects.
- 12 spin-off companies were established
- Over 60% experienced or expected to achieve increased competitiveness

- Half the companies reduced their costs
- The SMEs believed their technical reputation was improved

#### *Relations with the University Sector*

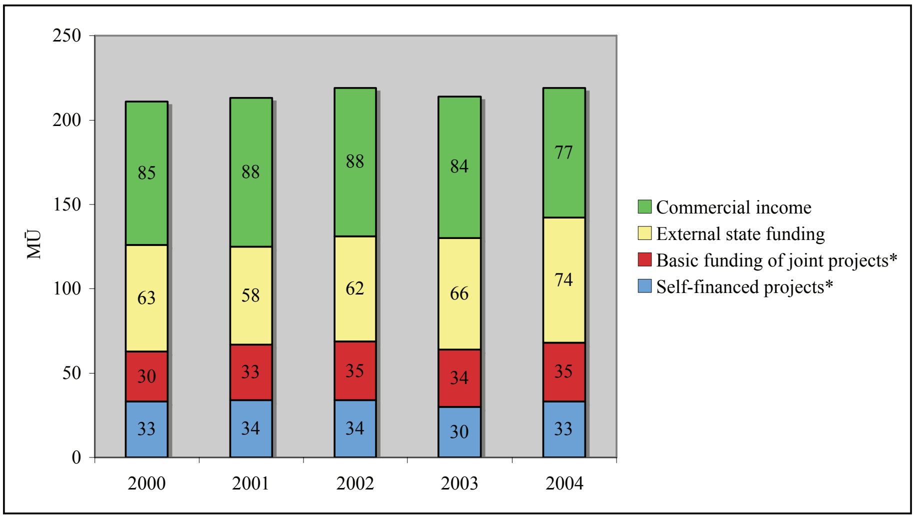
VTT believes it is facing increasing competition from the university sector, in two respects. First, its share of TEKES funding for industry-relevant research has fallen over the past decade, even though the absolute amount it has received in money has risen, so it has lost 'market share' to the universities. This loss of share is reinforced by the fact that universities have increasingly set up research groups that are not funded from the university block grant, and which therefore have to make a living in the contract research markets. Second, the strengthening of the regional colleges and universities in recent years means that VTT faces increasing competition in some technical services and consulting areas.

Given its size, the extent to which VTT interacts with universities is modest. About 10 VTT employees hold joint professorships with Finnish universities. As many as 60-70 hold the rank of 'docent' and teach part-time at universities. VTT hosts a number of 'researcher schools' for the Academy of Finland. These doctorands are paid a salary by the Academy. VTT makes no charge for housing them in its laboratories, but gets access to research results, which it can use in its strategic research, as well as joint publications. Some 15-30 PhDs graduate per year from VTT, and about 150 -200 people working at VTT are currently registered for a PhD.

#### *Financing and Revenues*

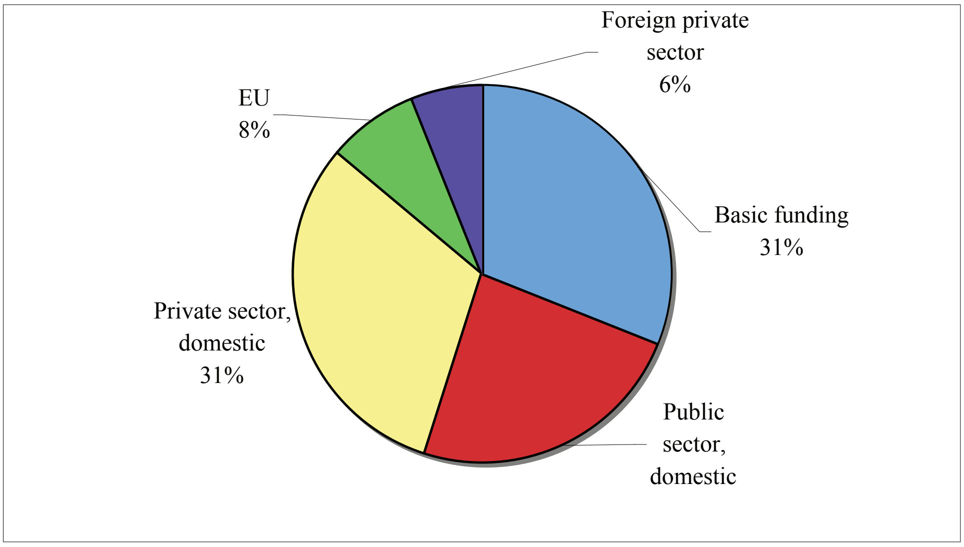
VTT has enjoyed 30-31% core funding from government for many years. It expects this level to rise to 40% over time, as a result of the new strategy of focusing on VTT in future innovation policy.

**Exhibit 71 VTT Sources of Revenue, 2000-4**




***Source**: VTT Review, 2004*

**Exhibit 72 VTT 2004 Turnover (€218m) by Source**




*Source: VTT*

## IPR

Increasingly, VTT aims to invent and patent inventions. It has a portfolio of about 1000 patents and applies for about 50 per year. Where work is commercially funded, the company customer owns the IPR. Where research is funded from core funding, VTT owns it, and shares 10-20% of the net income with the individual inventor(s). It is the intention that IPR shall become a more important source of revenue than the current 1% or so of turnover.

## Management, Strategy and Future Perspectives

VTT's stated mission is

> *VTT produces research services that enhance international competitiveness of companies, society and other customers at all stages of their innovation process, and thereby creates the prerequisites for growth, employment and well being.*

VTT's strategy is to focus on the EU, but especially key sectors in Finland. It will seek additional corporate customers from the EU, focusing on industries in radical change. It aims to add more value for its customers by doing more strategic research rather than services (and will finance this through the expected increase in its core grant). At the same time, VTT intends to make a significant improvement in its staff's understanding of business and business management, so that they can more closely engage with customer needs.

The new, complex and centralised organisation clearly increases transaction and coordination costs, implying a greater role for central approvals and data collection and associated delays in decision-making. To manage the complexity, VTT is introducing an Enterprise Resource Planning system. It is hard to see how such a large, multi-dimensional organisation can be managed without such a tool.

## B.4 TNO – The Netherlands Organisation for Applied Scientific Research

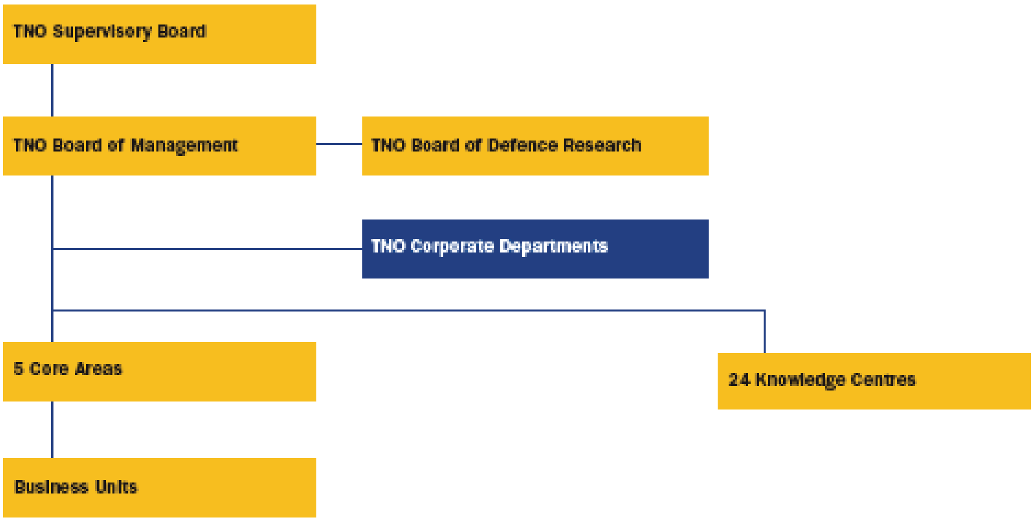
TNO states its mission as "To enable scientific knowledge to strengthen the capacity of businesses and government to innovate" and its objectives in its current strategy as

- To collaborate with companies, government bodies and knowledge institutions
- To undertake activities of relevance that have a demonstrable impact on society
- To occupy a unique and distinctive position in both the national and international knowledge infrastructures

### Composition

A small executive board of three people manages TNO as a whole, and the bulk of the operational management takes place at the level of TNO's five core areas and in the business units. The TNO Supervisory Board comprises a chair and six members, appointed by royal decree. Since the amendment of the TNO Act in 1985, the Ministry for Education, Culture and Science no longer appoints a member, though it remains the prime ministry responsible. TNO reports annually to OCW, using a balanced score card, and more recently it has begun also to report to other key stakeholders. However, these reports are confidential and this chapter is based solely on publicly available materials.

**Exhibit 73 Organisation of TNO, 2005**



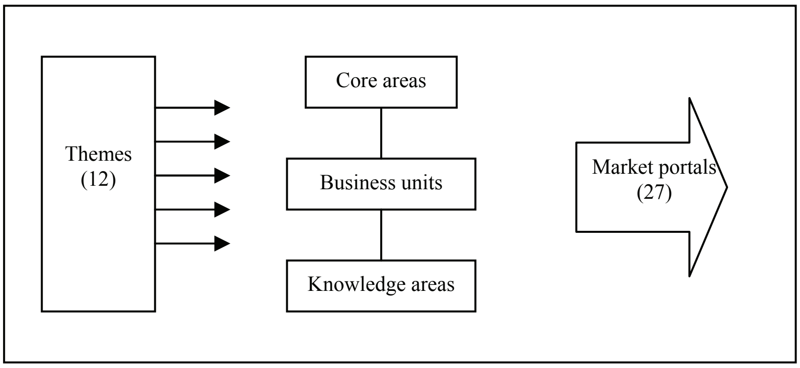

***Source**: TNO Annual Review, 2005*

Up to 2005, TNO was organised as 15 large institutes. These have been replaced by 5 core areas, which are

- Quality of Life
- Defence, Security and Safety
- Science and Industry
- Built Environment and Geosciences
- Information and Communications Technology

Like VTT, TNO has chosen a complex form of organisation (Exhibit 74) in order to tackle what it sees as its market and development challenges and the need to respond to the current change in the way it is funded. TNO is organised vertically into three levels: the core areas; each of which is sub-divided into Business Units; which are further sub-divided into knowledge areas. Knowledge areas are the operative level, where projects are performed. Business units may be distributed across more than one physical location.

**Exhibit 74 TNO, Schematic Organisation**




TNO's strategy defines 12 themes, on which TNO has decided to focus its work for the rest of this decade. Each has a theme manager and is matrixed across the core areas, with one core area taking the lead on each.

**Exhibit 75 TNO Themes, Strategy 2007 – 2010**

| Theme | Lead Core Area | Lead Ministry |
|---|---|---|
| Public safety | Defence, Security and Safety | BZK |
| Defence | Defence, Security and Safety | DEF |
| Healthy living | Quality of Life | VWS |
| Food | Quality of Life | LNV |
| Dealing with a changing society | (varies) | VenI |
| Work participation and ageing | Quality of Life | SZW |
| Accessibility | Built Environment and Geosciences | VenW |
| Construction and spatial development | Built Environment and Geosciences | VROM |
| Living with water | Built Environment and Geosciences | VenW |
| Energy (management) | Built Environment and Geosciences | EZ |
| Natural and built environment | Built Environment and Geosciences | VROM, LNV |
| High-tech systems, processes and materials | Science and Industry<br>ICT | EZ |

***Source**: Strategisch Plan TNO 2007 – 2010*

Each core area has a manager responsible for marketing. These people meet frequently and divide the lead responsibilities for the 50 or so key customer accounts. (A combination of visit reports and a unified database of project experience means that they can see all the interactions with individual customers.) However, for acquiring new business there is a separate system of 27 'market portals', who are individual people identified on the TNO web site and elsewhere as being responsible for guiding customers to the right expertise within the organisation.

In addition to the main organisation, TNO owns about 40 companies in the Netherlands and abroad, many of which are spin-offs. (TNO says that it spins out about 10 companies per year.) Those outside the Netherlands are primarily concerned with software distribution and in some cases with selling TNO services. While TNO's companies work in a wide range of branches, about 55% of their income is from services. The next-largest sector is automotive.

Exhibit 76 shows key figures for the Group (including the companies) and the main TNO organisation. There are about 4500 people in the main organisation and 500 in the companies. TNO is well capitalised, as is illustrated by its ability to cope with the need to make an unexpected €50m additional pensions provision in 2003. Labour turnover[61] was 10% in 2004 and rose to 12.5% in 2005.

**Exhibit 76 TNO Key figures, 2002-5**

| | TNO Group | | | | TNO Organisation | | | |
|---|---|---|---|---|---|---|---|---|
| | **2002** | **2003** | **2004** | **2005** | **2002** | **2003** | **2004** | **2005** |
| **Government Funding** | 186.8 | 188.6 | 194.5 | 195.8 | 186.8 | 188.6 | 194.5 | 195.8 |
| **Market** | 337.2 | 364.4 | 361.3 | 366.1 | 284.6 | 307.4 | 299.4 | 305.1 |
| **Total** | 524 | 553 | 555.8 | 561.9 | 471.4 | 496 | 493.9 | 500.9 |
| **Result** | 6.6 | -52.2* | 4.7 | 7.9 | 3.7 | -57.2 | 2.4 | 5.6 |
| **Employees** | 5003 | 5123 | 4979 | 4746 | 4493 | 4598 | 4473 | 4598 |
| **Equity** | 221.1 | 168.8 | 173.4 | 181.3 | | | | |

***Source**: Annual Reports   * Loss caused by exceptional pensions payment of €56.8m*

## History[62]

TNO was established under the TNO Act[63] in 1930 and began work in 1932. It was set up because of growing recognition of the importance of R&D and the clear success of the knowledge infrastructure in agriculture, which implied that a model of providing extension services could be modified to operate with industry as well. During the First World War, when Dutch industry became cut off from its foreign suppliers, it became clear that the Dutch scientific community was not able to support industry. At the same time, the commercial efforts of the faculty at the University of Delft were becoming so important that they were neglecting their educational tasks.

Originally, TNO comprised a handful of small branch-oriented advisory organisations, each employing 20 to 30 people and focusing on providing advice to SMEs, but they rapidly developed R&D capabilities. After the Second World War, TNO recognised that most of the areas in which it worked were interdisciplinary, and grouped what was by then a proliferation of small institutes into four major organisations, respectively handling

[61] Number of people leaving during the year divided by total year-end employment
[62] Much of this section is based on Gerard van de Schotbrugge, *TNO, R&D between public services and private enterprise*, (mimeo), Delft: TNO, 1996
[63] The Act on Applied Scientific Research in the Netherlands

- Industrial technology in general
- Food and nutrition
- Medical research
- Defence research

Each of these organisations was a separate legal entity and had a high degree of autonomy. This structure persisted until 1981.

During the 1960s, rapid growth and generous state funding (75% of turnover, provided in the form of a mixture of core and contract funding) allowed TNO institutes increasingly to retreat from applied work into more exploratory technological research. However, in the Netherlands as in other countries, the 1973 oil price crisis, changed perceptions of the environment and financial stringency led government to demand more socially useful results in exchange for financing TNO and a requirement that TNO be funded by the market to a much greater extent than before. TNO responded with increased central management control of the whole operation. Based on the second TNO Act in 1985, a number of other institutes in areas such as health and defence research were merged into the organisation, which then comprised some 15 institutes. Through the 1980s, TNO aimed to increase the share of contract research in its turnover and to operate more internationally. Internally, it aimed to develop a more market- and client-oriented culture with a clearer sense of its business capabilities.

In 2003, an ad hoc committee under the chairmanship of HHF Weiffels evaluated[64] TNO and the other large research institutes, concluding that while TNO's structures were strong, it should further strengthen its links both with universities and with social needs and that these needs should more directly de defined in cooperation with stakeholders, rather than by government and the administration. The institutes should also be given more autonomy to govern their own affairs. This has led to a reform in TNO's basic funding. Competence development funding, under TNO's own control, has been reduced to €13m (7% of turnover). The rest of the core funding is allocated to 'demand driven programmes', which are planned and road mapped together with a range of stakeholders (including the universities). This is intended to link TNO's strategy and thematic objectives more closely to social needs than before.

### Role in the Innovation System

The Weiffels report emphasised that TNO's role is to bring knowledge into application through direct contact with knowledge users and to serve as a bridge to connect them with other knowledge sources.

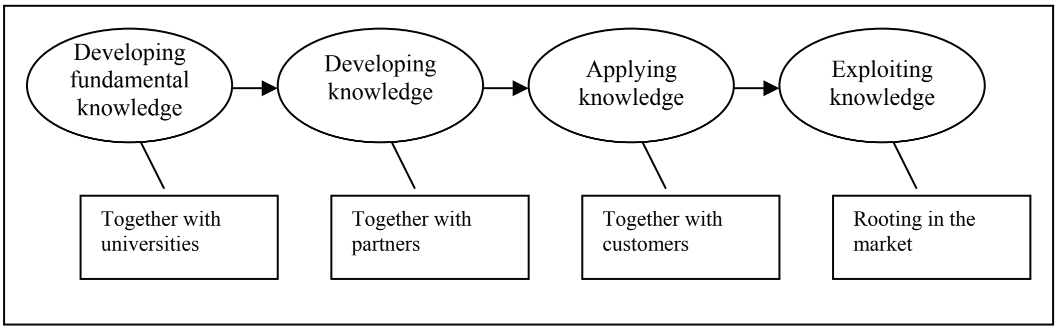
---

[64] Weiffels Commission, *De kracht van directe verbindingen*, Den Haag: May 2004

***What TNO Does***

TNO uses a similar schematic to other institutes, in order to explain its innovation process (Exhibit 77).

**Exhibit 77 TNO Innovation Model 'From Concept to Innovation'**




*Source: TNO*

'Developing fundamental knowledge' is done not only with universities but also other institutes, companies and EU programmes and is backed up by three-yearly audits of each component institute's position. The Knowledge Centres play an important role here. Applying knowledge is a one-to-one activity with knowledge users – companies and other organisations – co-financing the work. Exploiting knowledge includes spin out, licensing and other forms of traded IPR.

In the mid-1990s, TNO described[65] its work as

- Strategic research 15%
- Applied research 55%
- Consultancy 30%

Strategic research involves long-term and relatively costly work with a high degree of risk and no direct application in the market, but with a likely market application potential within 3 years. TNO described this as keeping its stock of basic knowledge (on which all clients can draw) up to date and charting developments important to TNO's strategy. It therefore corresponds closely to the k-funded work of the Swedish institutes.

Applied research focuses on answering specific questions by applying existing knowledge to new products, markets and processes. The manpower needed to carry out this work can be estimated relatively well and the tasks include materials, process, product and systems development as well as studies of technology and business economics.

[65] Gerard van de Schotbrugge, *TNO, R&D between public services and private enterprise*, (mimeo), Delft: TNO, 1996

Consultancy is work responding directly to clients' statements about their problems, for example feasibility studies, consultancy, audits, training, measuring, testing, certifying, technology transfer and providing facilities and instruments. These rely on existing techniques and satisfy clients' short term needs.

***Customers***

In 1995, TNO's revenues from companies were divided

- Fewer than 50 employees 45%
- 50 – 500 employees 35%
- Over 500 employees 20%

Currently, about half TNO's company revenues are from SMEs (according to the EU definition of SMEs as employing up to 250)[66].

***Relations with the University Sector***

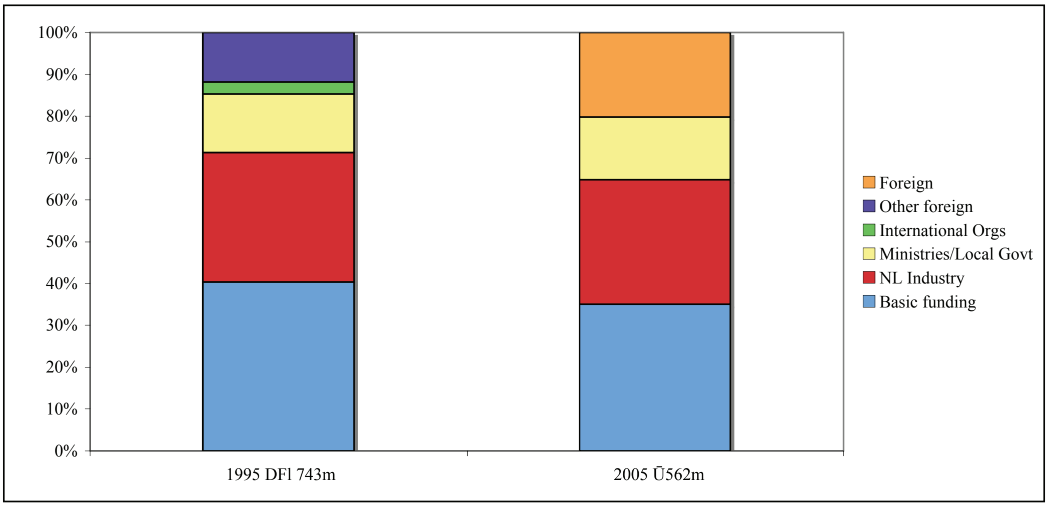
The Knowledge Centres (Exhibit – of which there are currently 30[67]) are joint centres involving TNO with universities, other institutes and companies. TNO personnel work together with people from the partners in joint research projects. About 50 TNO staff members are part-time professors. Normally, some 100-150 PhD students employed at the universities work on TNO projects, often in the Knowledge Centres.

***Financing and Revenues***

In 1995, TNO's revenues were DFl 743m, of which 300m 40% were in government core finance and the balance of 443m (60%) in contract research. In 2005, the proportion of government finance was slightly lower (45%) and the proportion of work won in competition correspondingly higher at (55%). By 2005, the proportion of basic funding from government had declined to 35% and the proportion of revenue coming from abroad had risen from 15% to 20%. Most of the foreign income continues to be from industry rather than R&D funders such as the European Commission.

[66] Annual Report, 2004
[67] http://www.tno.nl/tno/wie_we_zijn/organisatie/index.xml, accessed 27 August 2006

**Exhibit 78 TNO Revenues, 1995 (DFl 743m)**




***Source***: *DFl 743m corresponds to €230m at the exchange rate at which the Euro was introduced*

The basic funding has now been split into two parts. TNO currently gets 7% of its turnover in the form of un-earmarked core fund. The other 28% of the core funding is 'demand-driven', in the sense that TNO has to co-plan its use with stakeholder groups. These programmes are road mapped together with stakeholders and TNO has to report its progress annually to stakeholders as well as to the ministries that fund it.

### IPR

TNO has a well established patents and licensing department. It does not publish its income from this source, but that does run into "several millions" of Euro per year. The other major way of exploiting IPR is through spin-off companies.

In general, TNO tries to ensure that the intellectual property it generates is protected. Often, however, this means that a partner company rather than TNO takes the patent. Were TNO to take a more aggressive position, it would risk competing with its customers.

### Management, Strategy and Future Perspectives

In the mid-1990s, TNO (like Fraunhofer) announced that it intended to internationalise its activities. It set up an office in Prague to develop its activities in Central and Easter Europe. Currently, it has a representative office in Brussels, laboratories in Detroit to serve the automotive market and in Japan (food and pharmaceuticals), and it has recently purchased 10% of Joanneum Research, a 300-person institute until then fully owned by the Austrian Land of Styria. The initial 15 joint projects between TNO and Joanneum have been reduced to 7 and the two organisations are together looking for third-party finance for contract R&D in these areas. Overall, however, TNO argues that it is hard to persuade national government of the need to internationalise, and this tends to limit its enthusiasm.

TNO sees the drivers for changing its role and financing model as

- Increasingly complicated social issues
- Economic stagnation, less concern with for importance of innovation
- Social need for essential innovation leading to new high-quality business
- Production and knowledge-intensive activities to low cost countries
- Global purchase of knowledge
- Innovation paradox
- Open innovations at companies[68]

TNO's thematic strategy is summarised in Exhibit . Overall, TNO says that there are about 160 other research institutes in the Netherlands, and that successive governments have tended to try to address new problems by launching new institutes. It is pressing for a simplification into a six-part structure comprising

- NLO (agriculture)
- Energy
- Health
- Delta research (rivers, hydrology, construction in related areas such as flood control and dykes)
- Social research
- Technology and defence (TNO, with the addition of other institutes)

This would produce a structure with about 5000 people per institute.

## B.5 IMEC – Interuniversity Microelectronics Centre, Leuven

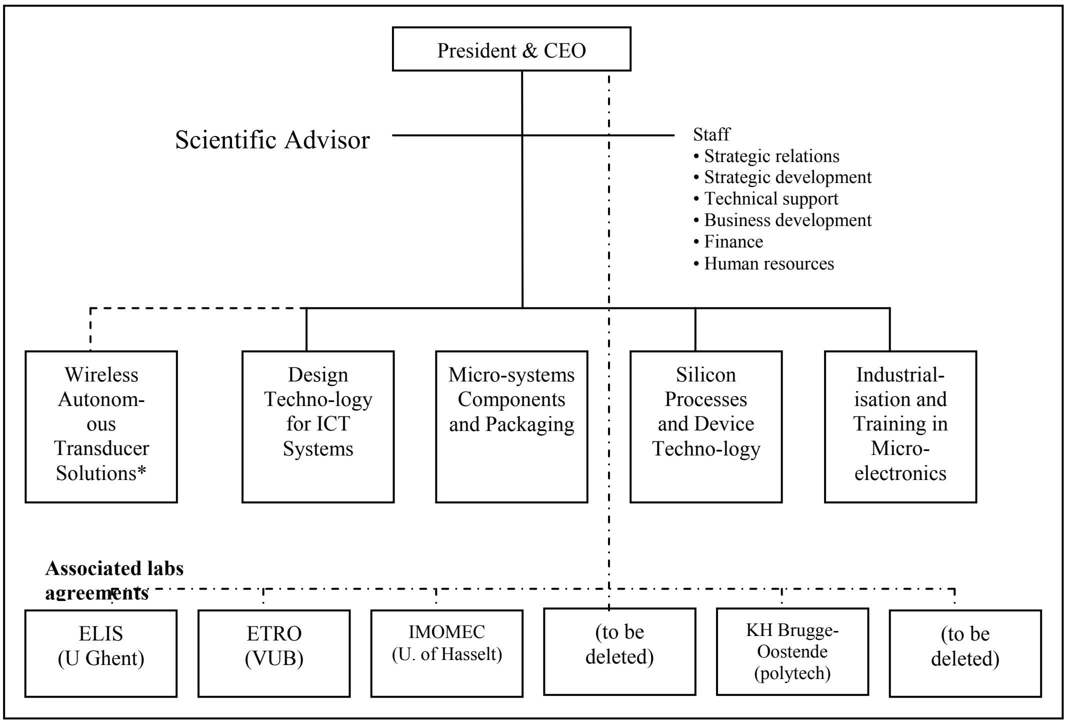
### Composition

IMEC's stated mission is *"To perform R&D, ahead of industrial needs by 3 to 10 years, in microelectronics, nanotechnology, design methods and technologies for ICT systems*." It aims to: be an "international centre of excellence"*;* to reinforce the local industry; to cooperate intensely with Flemish universities and to provide industrial training in ICT. This involves building strong background information and exploiting a business model for cooperative research that IMEC regards as unique. Key elements are global

[68] Presentation *New TNO*, 30/5/06; provided to us by the TNO Strategy Director

networking with customers and researchers and working in multidisciplinary teams.

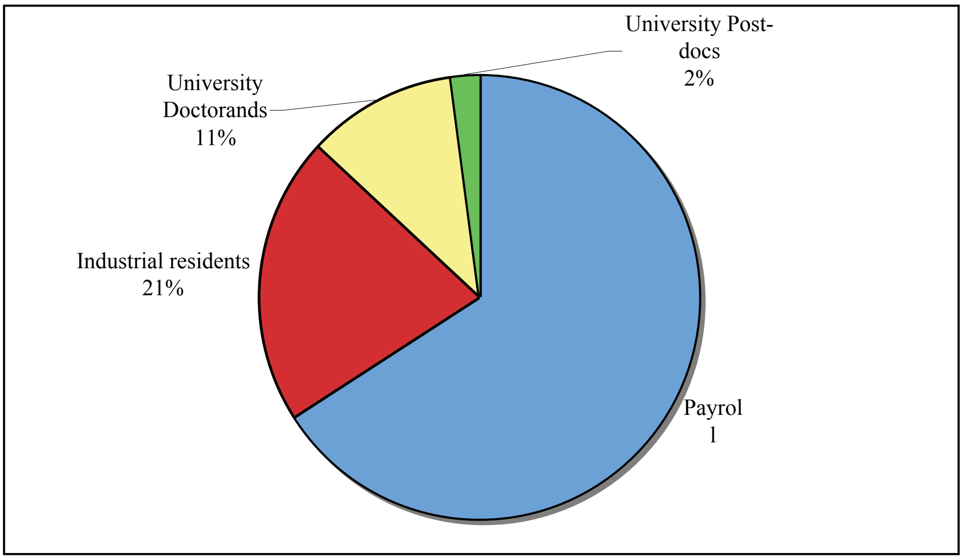
**Exhibit 79 IMEC Organisation, 2005**




** A separate legal entity in The Netherlands, part of the Holst Centre*

An important and unusual aspect of IMEC's operations is the large numbers of people being employed by its industrial and academic partners at the Centre as residents, together making up one third of its total staff (Exhibit 80). This makes IMEC's collaborations unusually **active** compared with many other institutes. In part, this is a result of IMEC's use of university relationships as a way to interact with more fundamental research and to obtain inputs to its 'knowledge pipeline'. In part it is also driven by IMEC's role as a research platform and a test-bed for new types of design, advanced packaging and processing technologies, … for the microelectronics industry, based upon a state-of-the-art research infrastructure, which allow industry to have a strong 'hands on' role together with IMEC researchers, in an open innovation type of multi-partner collaboration.

**Exhibit 80 IMEC Employment December 2005 (1402)**




***Source****: IMEC*

IMEC's employees are, on average, very young: 35 years, in 2005. Two-thirds of the total staff is actually on IMEC's payroll (Exhibit 80), while a fifth is seconded from IMEC's industrial partner organisations to work at the institute as residents. The remaining people are PhD-students and post-docs.

### History

Like many other governments, that of Flanders decided in the early 1980s (1982) to set up a wide-ranging programme of activities to ensure that the region would benefit from the production and use of Information Technology. The INVOMEC programme tackled education of microelectronics design engineers across the Flemish higher education system and organised the production of prototype quantities of experimental circuits for education and product development.[69] In 1984, IMEC – the Interuniversity Microelectronics Centre – was set up to link the developing microelectronics capabilities in Flemish universities and to do more application-oriented research than was possible within the universities themselves taking into account the high cost of research infrastructure needed to perform such kind of research.

Although Flemish industry at that time included not only a number of microelectronics using companies but also a significant presence from Philips, IMEC quickly recognised the need to operate at an international level to build enough critical mass and developed a business model that

[69] Erik Arnold and Ken Guy, *Parallel Convergence: National Strategies in Information Technology*, London: Frances Pinter, 1986

involved bringing multiple industrial partners together on a one-to-one bilateral contract basis, to explore and develop the knowledge and capabilities needed to tackle next generations of design methods and micro-electronics process technologies. IMEC has therefore, over time, been able to perform its mission statement with a structural public funding, that has moved from being the bigger part of its revenues in its early years, to being a small fraction today (about 15% - 2006).

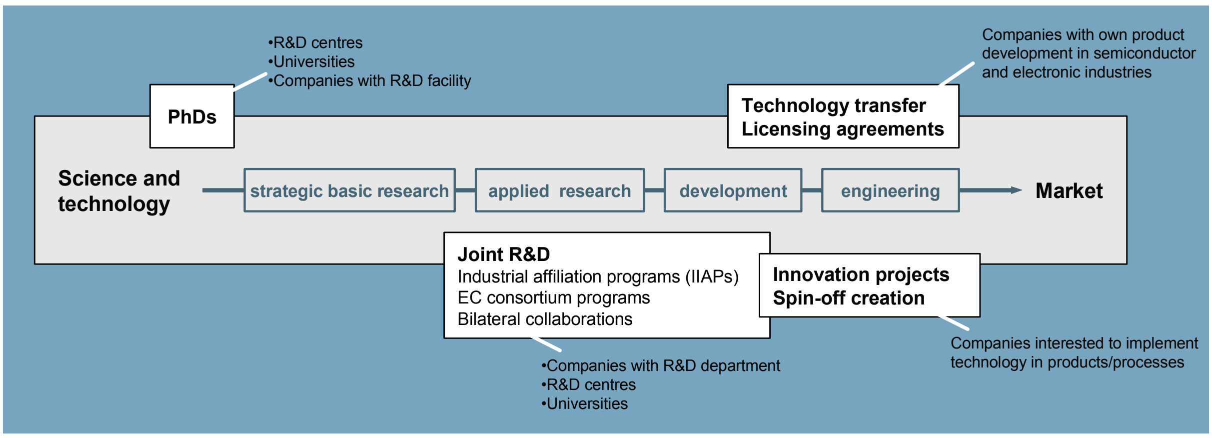
IMEC's major research focus, in terms of efforts being deployed, has been mainstream silicon microelectronics process technology, supporting the industry need and ability to put successively smaller features on microchips, thereby allowing increasing integration and complexity of circuitries. A key to its recent success is the fact that in 2004-2005 it was able to persuade its industrial partners and the regional government together to finance a-state-of-the-art pilot line able to process 300mm diameter silicon wafers – an investment of some €400M, which was ready for use in 2006. The building and general utilities alone required an investment of €84M. The bulk of the total investment was equipment-driven. This provides IMEC with a unique advantage, since it is one of the few independent microelectronics research lab worldwide to possess such a facility.

## Role in the Innovation System

### *What IMEC Does*

IMEC has a fairly conventional model of the innovation process (Exhibit 81). However, the extent of interaction with universities, at the early stage in particular, is very strong.

**Exhibit 81 IMEC in the Innovation Life Cycle**




***Source**: Herman Maes, 'IMEC's Approach to Reconcile its Dual Mission of Global Research Excellence and Support of Local Innovation', presentation to Innovation Policies in Support of ITC, Brussels 12 November 2004*

***Customers***

IMEC serves six groups of customers (though some companies appear in more than one group):

1 The top-ranking global microelectronic chip manufacturers community (IDMs), especially those working with silicon technologies, such as Intel, NXP (ex-Philips Semiconductors), Infineopn, STM, Matsushita, Texas Instruments, Samsung, TSMC, Freescale, …. Indeed, this list also includes NXP, (ex-Philips), which arguable maintains a significant presence in Flanders because it uses IMEC as its home-basis for advanced processing technology research.
2 Major international companies involved in other microelectronics technology areas (e.g. packaging, wireless communication, sensor networks and or design technologies (e.g. Samsung),
3 Suppliers of equipment and other specialised semiconductor materials, such as ASML, ASMI, Applied Materials, Tokyo Electron, …;
4 Its own spin-off firms, in which it may hold a minority shareholders stake;
5 Other local companies, which IMEC supports with a range of innovation oriented activities, such as awareness creation, training, assistance to product development and so on. About half of these activities are ito be situated in the ICT sector and the rest are scattered across a range of others areas of economic activities. IMEC cooperates with both larger R&D prone companies and with SMEs. In the latter case, IMEC often helps such SMEs to apply for supportive co-funding from IWT, the Flemish innovation agency;
6 A collection of Flemish higher education institutions as well as a wider range of companies, to which IMEC provides education, training and prototyping services through its dedicated INVOMEC-division;

With many of the above categories, IMEC also cooperates in the context of EC projects (Framework Programs) or Eureka-projects.

***Relations with the University Sector***

Until 2002, some 10% of the IMEC ‘grant’ was to be spent on joint projects with local universities to fund longer-term research projects in areas of strategic interest to the institute. Since, 2002 this obligation was abandoned by the Flanders Government and has been replaced by the Flanders-wide SBO (Strategisch Basis Onderzoek) scheme, to which all Flemish universities can apply directly on a competitive basis. However, IMEC has continued to provide training and logistical support to the partner laboratories,and to cooperate with the local universities in joint research projects (e.g. SBO or EC or Eureka) on a case-by-case basis.

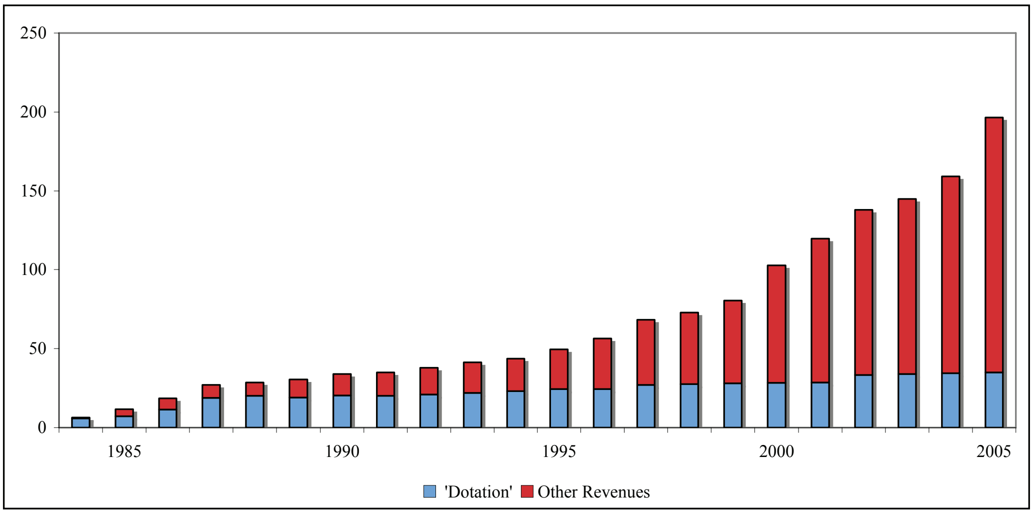
A key component of continuing relations with the universities is based on having PhD-sudents and postdocs performing their research at IMEC’s facilities. Over 200 PhD students, most of which are registered at the partner universities, actually work at IMEC's premises and a certain number of IMEC's own staff (about 30) teach part-time at these universities.

In 2005, IMEC had some 550 industrial partnerships, world-wide, and in the context EU Framework Programme projects.

### Financing and Revenues

Exhibit 82 shows how IMEC's total revenues have developed since 1984, when it began operations. IMEC's structural funding comes in the form of a yearly 'grant', against which a number of key performance indicators have been put by the Flanders Government. In return for this grant, the institute is expected to be an international center of excellence and to provide benefits to the Flemish economy and to the universities in several ways, including spill-overs from its normal research (e.g. spin-off companies), specific services to Flemish industry (both inside and outside the electronics industry), training, prototyping services and research alliances with regional universities. The yearly grant grew quickly, from €6m to €20m in the first five years, as IMEC became well established and reached a level of about €35M in 2005. Indeed, since its first 5-year agreement with the Flanders Government, the structural grant generally grew at an inflation-level pace, while IMEC's external revenues have dramatically increased during the same period.

**Exhibit 82 IMEC 'Grant from the Flanders Government' and Other Revenues, 1984-2005**




***Source***: *IMEC Annual Report, 2005*

Another requirement of the grant is that IMEC has to yearly report the above performance indicators . Its performance is measured against the achievent of those KPIs. The indicators currently in use are illustrated in Exhibit 83. Like all the major research institutes funded by the Flemish government, IMEC is evaluated every fifth year, after which negotiations between IMEC and Flanders start about the terms of the next five-year funding period.

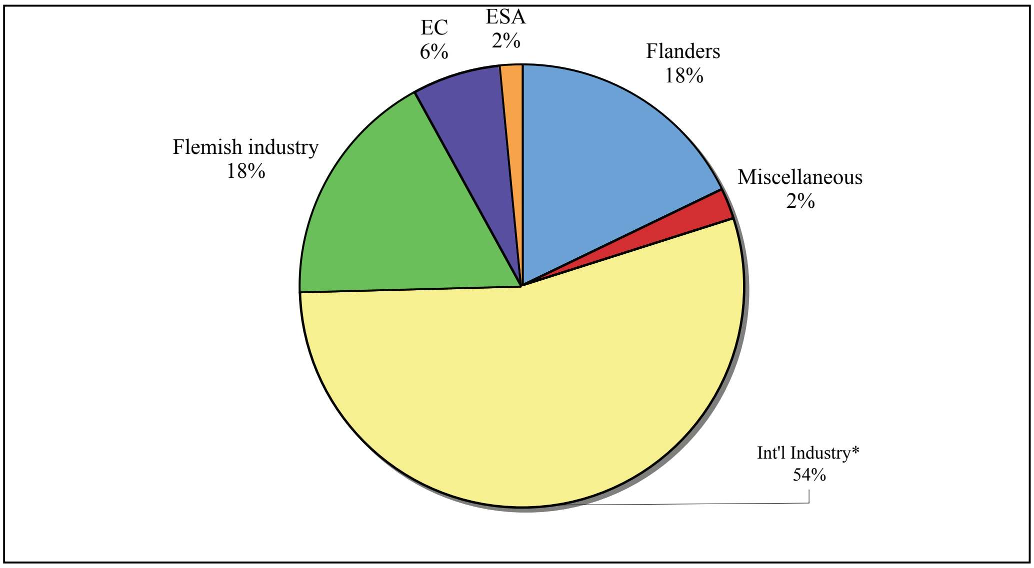
**Exhibit 83 IMEC Performance Indicators, 2004**

| Indicator | Value |
|---|---|
| Contract Income (M€) | 99.2 |
| # Publications | 1100 |
| # Invited papers | 21 |
| # Ph.D. students | 125 |
| # Contracts with Flemish Universities | 33 |
| # Publications with Flemish Universities | 480 |
| Total revenue Flanders (M€) | 16.8 |
| # Contracts SME's | 100 |
| Revenue SME's (M€) | >3.06 |
| # Spin-offs/year | 1 |
| Collaboration New SME's | 5 |
| # contact hours (training) | 5468 |

***Source****: Herman Maes, 'IMEC's Approach to Reconcile its Dual Mission of Global Research Excellence and Support of Local Innovation', presentation to Innovation Policies in Support of ITC, Brussels 12 November 2004*

In 2005, IMEC's total revenues were just under €200M. The sources of revenues are shown in Exhibit 84.

**Exhibit 84 IMEC Revenues, 2005 (€197M)**

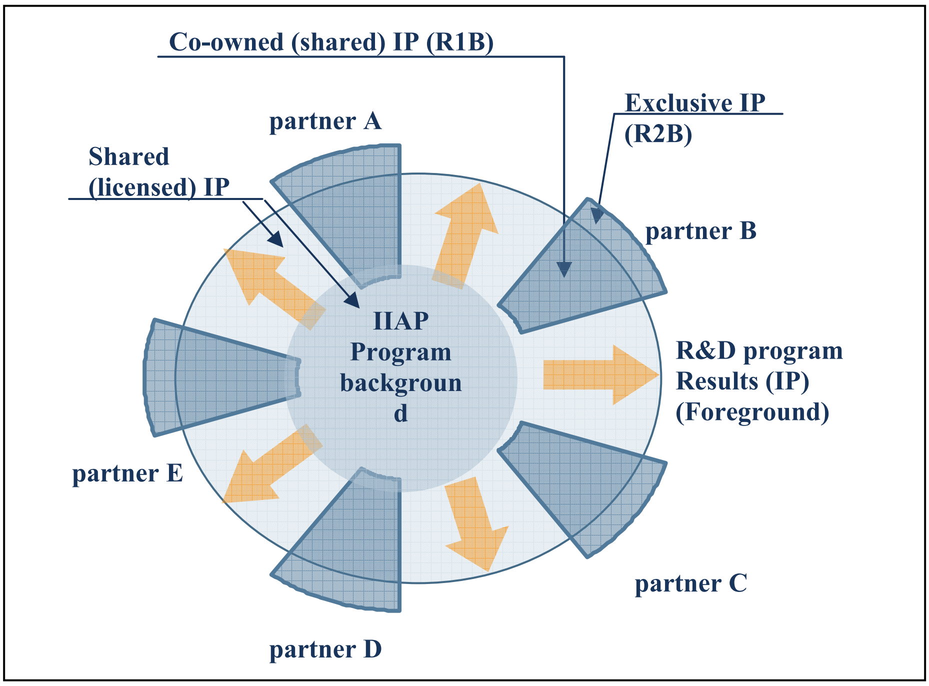



***Source****: Calculated from figures given in the IMEC Annual Report, 2005*
*•Includes Europractice revenues (see below)*

**IPR**

Since IMEC generates its own IP in the parts of the work that is internally funded, it is in a position to support new spin-off companies and to provide them with IP rights through dedicated licensing agreements. In some cases, IMEC stops certain fields of research when it spins off a company, in order to avoid competing for R&D funding with its spin-off. IMEC has recently set up an independent seed- and venture capital operation (Capital-E), which makes use of external inputs and co-financing, in order to ensure that new business ideas and spin-offs potentials are assessed in an as objective way as possible.

**Exhibit 85 IMEC Business and IPR Model**




***Source**: Herman Maes, 'IMEC's Approach to Reconcile its Dual Mission of Global Research Excellence and Support of Local Innovation', presentation to Innovation Policies in Support of ITC, Brussels 12 November 2004*

The main instrument for interacting with the international industry is the IMEC Industrial Affiliation Program approach (IIAP). These research program-driven approach involves R&D addressing generic problems together with a group of companies. The aim is to build reusable technology platforms, sharing costs and risks among IMEC and the industrial partners, and by sharing most of the IP that results from such cooperation. IP parts of a more generic nature may be shared amongst multiple partners. In this way, IP resulting from such more generic work does not block the use of other knowledge that depends upon it. Other R&D done on behalf of a single industrial partner, based upon company specific data, is provided on an exclusive rights basis to that company.

### Management, Strategy and Future Perspectives

As a large institute working with a manageable number of related research themes, IMEC has at the upper levels a fairly conventional line structure, with 4 divisions and a staff. The SPDT division accounts for about two thirds of the institute's personnel, including the technician-intensive pilot-line and clean room facilities. The other divisions have a larger proportion of scientific staff and PhD students.

Within the scientific divisions, IMEC tends to use a matrix form of organisation, with program managers drawing resources from multiple disciplines. In a growing number of cases, program teams extend across division boundaries, reflecting a growing ability to tackle complex, applications-driven problems in addition to IMEC's more process technology oriented focus.

Since it is generally believed that line widths on chips will reach the physical limits within about 10 years, IMEC has clearly chosen to build its corporate strategy on two pillars: "More Moore' and "More than Moore". It allocates part of its structural money towards these newer "More than Moore" areas, in order to help build further capabilities in those areas. A lot of new nanotechnology breakthroughs will build on nano-electronic CMOS platforms, providing IMEC with a strong differentiating power. PhD students also have proportionally a stronger concentration in the 'More than Moore' areas.

## B.6 Arsenal Research

We had hoped to include the Austrian Research Centres group of institutes as a case study. However, the central management were unable to assist us at the time of the study. The directors of the Arsenal Research and ARC Systems Research kindly agreed to be interviewed. The results of the discussion at Arsenal are documented here. The Systems Research discussion has more broadly informed the analysis in the report as a whole.

### Composition

As a member of the Austrian Research Centres group, Arsenal is supervised and financed through the ARC holding company.
The activities and staffing of Arsenal Research have been altered drastically since it was brought into the Science Ministry and the ARC group. Its activities now focus on transport and energy

- Transport technologies
- Transport route engineering
- Human centred mobility technologies
- Monitoring, energy and drive technologies

- Sustainable energy systems
- Renewable energy technologies

The corresponding groups function as profit centres within Arsenal. The managing director has a small staff, and is supported by a seven-person scientific advisory board.

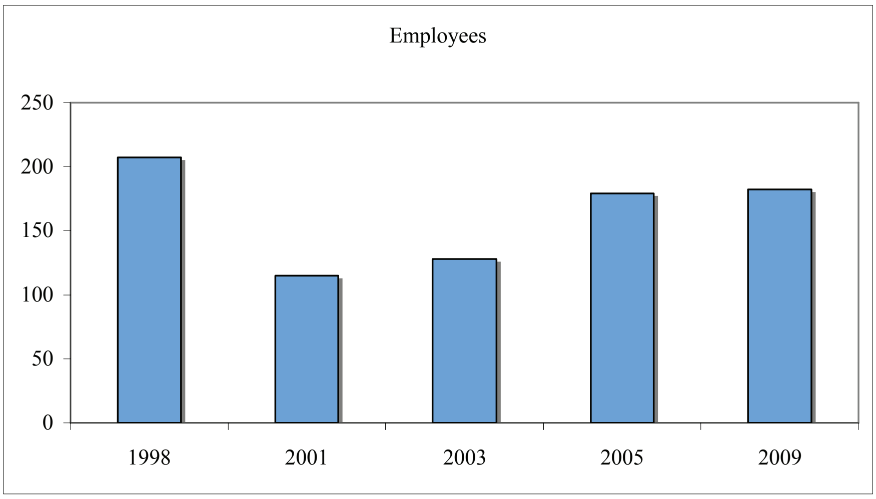
While measurement and test remain important, the management have changed the direction of the work significantly towards research. To do this, about half the equipment stock was written off, with correspondingly large financial losses. A large cash injection was needed in order to rebuild the institute's finances. The restructuring process took about 18 months. Some 80% of current activities were not performed prior to the year 2000. The staff has largely been renewed: of 207 people in the institute in 1998, only 45 remain. About 35 of the old staff were transferred to Seibersdorf, in an exercise to create a clear division of labour between the two institutes. Researchers have been recruited internationally, and there are now 8 PhDs in progress. Staff qualification levels have dramatically increased. A complication arising from the change in legal form of the institute to become a limited company is that 59 employees are still employed as civil servants, while the balance have normal, commercial contracts of employment.

**Exhibit 86 Arsenal Employment 1998 and 2005**

| | 1998 | 2005 |
|---|---|---|
| Total staff | 207 | 179 |
| Proportion with a university degree | 35% | 59% |
| Average age | 42.3 | 35.62 |

***Source****: Arsenal Research*

**Exhibit 87 Arsenal Employees 1998-2009**




***Source****: Arsenal Research*

Key Performance Indicators are being collected in connection with the monitoring of Arsenal's core funding. A selection is shown in Exhibit 88, from which it is clear that the institute has been very engaged in practical work for industry, communicating with it through public channels such as conferences, and that it is at a comparatively early stage of building up its research. Over time, indicators such as refereed scientific publications and staff with higher degrees should rise. A potentially useful indicator missing from the list is the number of EU projects in which Arsenal is currently engaged in total, which currently stands at an impressive 20 or so.

**Exhibit 88 Selected Key Performance Indicators**

| Key Performance Indicators | 2004 | 2005 | 2006 (plan) |
|---|---|---|---|
| No of scientific staff | 89 | 103 | 105 |
| No of international researchers | 14 | 18 | |
| Publications in refereed scientific journals | 2 | 0 | 1 |
| Contributions to conference proceedings | 59 | 55 | 60 |
| Publications in relevant journals | 13 | 15 | 20 |
| Presentations at international scientific conferences | 70 | 101 | 120 |
| No of University courses taught | 16 | 16 | 18 |
| Patents applied for | 1 | 1 | 2 |
| Patents granted | 1 | 5 | 2 |
| No of diploma projects | 20 | 26 | 30 |
| No of PhD students | 9 | 8 | 9 |
| No of staff with PhD or higher qualification | | 3 | 4 |
| No of EU projects and networks coordinated | | 9 | 9 |

***Source**: Arsenal Research*

## History

Arsenal Research has its roots in a collection of state-owned measurement and test facilities built up after the Second World War, including facilities for vehicle, electrical equipment and mechanical machinery testing, which were brought together under the ownership of the Ministry of Construction and Technology in 1964 and later (1987) transferred to the Ministry of Science and Research. In 1997, it was transformed into a sate-owned company (Austrian Research and Testing Centre Arsenal) 100%-owned by the state and in 1999 it became a subsidiary of Seibersdorf and from 2001 it was held directly by Austrian Research Centres (ARC, which is owned 50.46% by the republic and the balance by industry).

The present managing director was hired in 2000 from a position in industrial research management to improve the performance of the institute.

## Role in the Innovation System

### *What Arsenal Does*

Arsenal provides a mixture of testing and certification services and contract research. (The balance is not clear from available documentation, but appears still to include a high proportion of services.)

### *Customers*

Arsenal has a strong position in serving the local R&D centres of multinational companies such as Siemens, Bombardier and Alcatel. Since these centres are themselves in global competition, there is a strong interest both within them and at Arsenal in building positions that are mutually supporting. In addition to this customer segment, Arsenal has distinct plans for accessing the following groups of customers

- Authorities and other infrastructure operators
- Service firms
- Medium-sized firms (the Mittelstand)
- High-tech SMEs

Recognising that the cost of acquiring projects from SMEs is high, Arsenal tries to access this market through networks and branch organisations, which can generate projects large enough to repay the sales and marketing costs involved.

### *Relations with the University Sector*

Arsenal regards close university relations as essential for its future. In part, this is because it has a continuing need to recruit researchers and upgrade its capabilities. In part, the universities because Arsenal needs to cooperate in order to access some of the more basic knowledge generate it. The institute has a laboratory on site, which it shares with the Technikum Wien Fachhochschule. The possibility to offer such facilities is especially interesting in Austria where – with certain exceptions (notably at the Technical Universities of Vienna and Graz) – university laboratories tend to be “miserably” equipped.

Arsenal staffs now teach a great deal at universities. Austrian universities were said to be very inflexible and old-fashioned. At the same time, they lack the institute’s professional approach to contract research. Arsenal did not see them in any way as competitors.

## Financing and Revenues

The institute aims to get 40% of its income in core financing, a further 30% in subsidy projects and 30% on the private market. In 2004, the institute’s total income was approximately €15m. Some €6m comprised core funding and a further €1.5m was a one-time payment to help with restructuring costs. The balance of €7.6m came from the public and private sector markets.

Arsenal uses the core funding partly to co-fund projects together with subsidy programmes as well as to initiate its own research projects. Total public funding is therefore of the order of €9m.

In the early days, the Science Ministry (and more recently BMVIT – the federal Ministry of Transport, Innovation and Technology) negotiated in considerable detail about the projects that Arsenal would undertake, using the core funding. More recently, an experimental performance contract[70] has been drawn up between BMVIT and Arsenal's owner, ARC, that specifies higher-level goals, partly suggested by Arsenal itself in discussion with the ministry. In the meantime, BMVIT has lost a significant proportion of its staff in government-imposed cuts on the ministries. Both the reduction in planning capacity at the ministry and a wider desire to govern more in line with the principles of the New Public Management explain this reduction in detailed steering of the institute.

### IPR

Patents are important to Arsenal Research, not only because they may provide some income but most importantly because they demonstrate the competence of the institute in its research areas. They therefore help in project acquisition. Most of the patents held by the institute are in traffic telematics.

As with other contract research organisations, paying customers acquire the rights to intellectual property developed on contract to them. The institute's rights to intellectual property developed in state- or co-funded work vary among funding programmes.

### Management, Strategy and Future Perspectives

Before 2000. Arsenal was largely a test and measurement house. Changing the book-keeping system to reflect full costs (including the capital cost of the equipment used) was an important driver for reducing the scope of these activities, many of which were not financially viable. Only a process of radical organisation change and significant reengineering of business processes was sufficient to achieve the needed transition in performance.

The strategy of Arsenal Research has been to reposition itself from a focus on services to one founded in research, so as to become a significant research player in the fields of mobility and energy technology. The number

[70] At the time of writing, this was not yet in the public domain

of internal research programmes has been reduced from 10 to 5 in 2005 in order to

- Reach critical mass (20-25 researchers) in each theme
- Be internationally visible at the level of the individual research groups
- Obtain better market access through using larger teams

Since the institute has needed to narrow its scope and build a position in the research sphere, its business and market development strategy is rather focused

- Cooperating with universities and colleges to develop methods that can be exploited via contract research for companies or that enable new and interesting test services to be provided. Simulation and modelling and key technologies in order to achieve this
- Launching research projects that aim to make incremental improvements to current products or services, with the intention of strengthening the institute's knowledge, preferably in ways that can be protected by patents
- Networking, to establish Arsenal better as a player in the national and European research scenes

## B.7 The Fraunhofer Gesellschaft

The Fraunhofer-Gesellschaft was founded in 1949. Today it is the largest contract research organisation in Europe. It consists of 58 Franuhofer institutes employing a total staff of about 12,000 employees in 2005. The annual budget for 2005 was roughly €1 billion.

The Fraunhofer R&D portfolio covers all scientific and engineering disciplines of major importance to the German economy, ranging from materials science and production engineering to microelectronics, information technology, and the life sciences. Each of the 58 institutes is dedicated to a specific area of technology (e.g. laser technology, IT security, ceramics etc.) rather than being oriented towards a single sector of industry (e.g. furniture, automotive, food etc.) As a result, the Fraunhofer offers its services to a broad range of customers in different industrial sectors across 40 different locations in Germany. This strong regional presence is aimed at promoting local and national industrial economic development.

The Fraunhofer's key mission is to promote and undertake applied research in an international context, of direct utility to private and public enterprise and of wide benefit to society as a whole.

### Composition

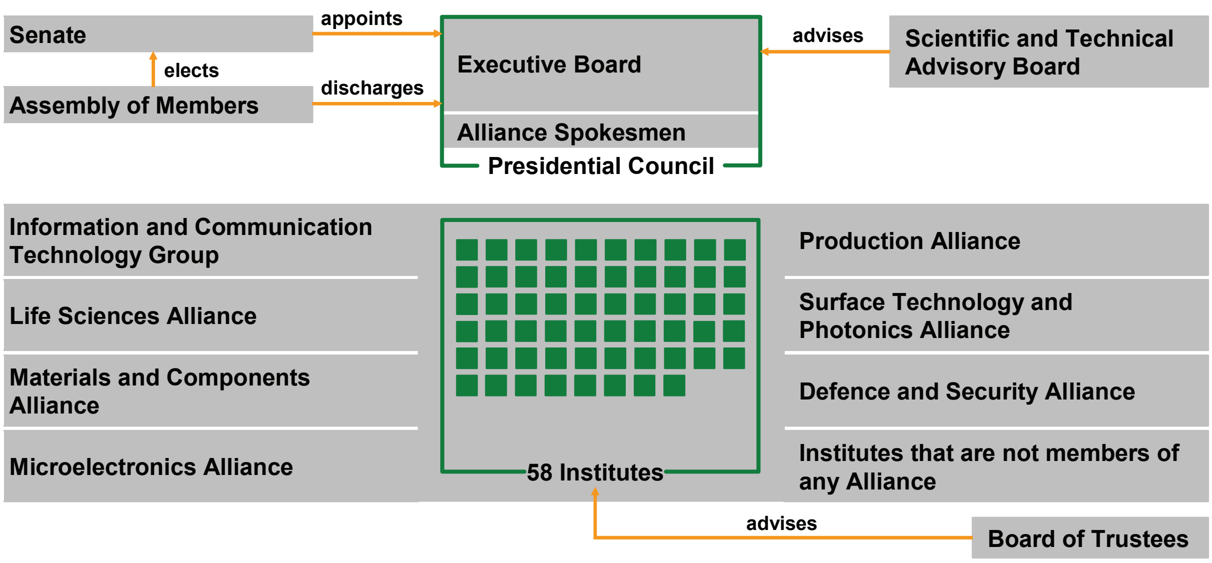
Each of the 58 Fraunhofer institutes is headed by an extremely powerful Executive Director who enjoys a high degree of autonomy in the institute's strategic planning, management and scientific profile. The Fraunhofer statute states that the institutes and directors should be free to organise themselves; they are free to decide on the organisation, policies and strategies of the institute.

Granting a high degree of autonomy to the institute's Directors has its advantages and disadvantages. The Directors are arguably very close to the ground and know their markets well. Many are ex-industry researchers. They are by far the most competent to devise institute strategy (though this is quality-assured by central Fraunhofer administration). The devolved model also leaves Fraunhofer robust to changes. If central Frauhofer make a mistake or if an individual institute fails, Fraunhofer the Brand remains stable. What is critical is that the missions of the institutes have some degree of overlap, that unnecessary research duplication is avoided and that diversification and co-operation can be efficiently encouraged. This is the key role of Fraunhofer's central administration, which is in practice rather hands off and does little to influence individual institutes' management, provided the institutes are economically successful.

Overlaying the institute structure are 7 'strategic alliances', which promote communication and common marketing across the institutes. The Fraunhofer Alliances are separate from the actual corporate management structure and have no official controlling functions.

Exhibit 89 sets out the structure of the Fraunhofer-Gesellschaft.

**Exhibit 89 Structure of the Fraunhofer-Gesellschaft**

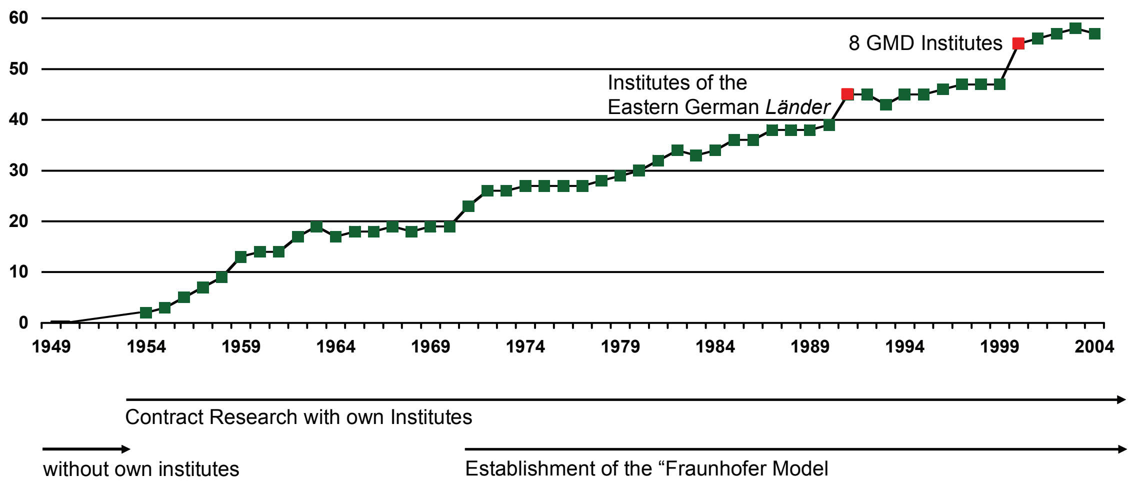


## History

The Fraunhofer emerged after the Second World War, partly as a result of accepting the project management task of distributing research funds for the Ministry of Defence. To this day, the Fraunhofer undertakes some defence-oriented research, but it is a minor part of the Society's activities.

However, the Fraunhofer model, which has grown from the introduction of core public funding, only took shape after 1977. Prior to this, the Fraunhofer only received project funding. The core funding allocations to Fraunhofer represented a *re-distribution* of existing public expenditure on research among German research performers but represented an important opportunity for the association's growth. See Exhibit 90.

**Exhibit 90 Development of the Fraunhofer Institutes**




## Role in the innovation system

The German innovation system, with its politically engineered mix of institutional players is decentralised and complex. National research is institutionally divided between the higher education and the public research institute sectors funded by federal and/or state governments.

The bulk of German R&D is industry-based though the higher education and public research institute sector play a key role in the innovation system. Unlike most other OECD counties, Germany has maintained the size of its public research institute sector over the past 20 years.

The four key public research institute networks are

- The Max Planck Gesellschaft (MPG): a non-profit registered society conducting *basic* research in its own network of about 80 institutes, concentrating on cutting edge and interdisciplinary research in the natural sciences, medicine, social sciences and the humanities. Its work is designed to supplement university-based research. 95% of MPG funds are from public sources. Core government funding for 2000 was €0.87 billion, and split on a 50:50 basis between federal and state sources

- The *Fraunhofer Gesellschaft* (FhG): a society focusing on applied research, largely in engineering and natural sciences, through its own network of 58 institutes, and working closely with industry. Core public funding for 2000 was €310 million, on a 90:10 federal state basis. FhG's budget comprises 35% core public funding, 35% from industry (mainly under contract), and 30% project funding, mainly from public sources, but also from foundations. FhG's work is designed to promote industrial economic development
- The Helmholtz-Gemeinschaft Deutscher Forschungszentren (HGF): an association comprising 15 independent large scale research institutes and facilities (many of which are available for use by researchers in other sectors) covering a broad range of technical, natural science, engineering and biomedical basic and preventive research and pre-industrial development research. The HGF core budget forms the largest single item of public research funding, €1.6 billion in 2000, split 90:10 between federal and state governments
- The Wissenschaftsgemeinschaft Wilhelm-Gottfried-Leibniz (WGL): an association comprising about 80 independent non-university institutes, which are generally small research and service-oriented institutes. Institutes' R&D activities are of general supra-regional interest, and are funded individually by federal and state authorities.[71] In 2000, the WGL institutes received €0.61 billion public funding, mostly on a 50:50 federal state arrangement.

There is clearly some overlap of activity across the institutes in the German system, though the balance of the type of research undertaken (fundamental to applied research) varies. Max Planck Gesellschaft is firmly positioned under fundamental research, as one might expect given their majority public funding. Fraunhofer in comparison, with its diversified funding sources covers a range of fundamental and applied research, putting it in competition with many of the other institutional players, including the universities.

Though there is one dominant federal Ministry for Education and Research (BMBF) that leads national research policy making and funding, there is no top-down national management of the innovation system. Instead, endowed (and constrained) by their funding sources, the division of research labor is left to institutes themselves. A systems-wide evaluation on the national system of innovation has never been undertaken and has been politically avoided despite internal evaluations by the institutes that identify sub-

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[71] A small secretariat addresses concerns common to member institutes

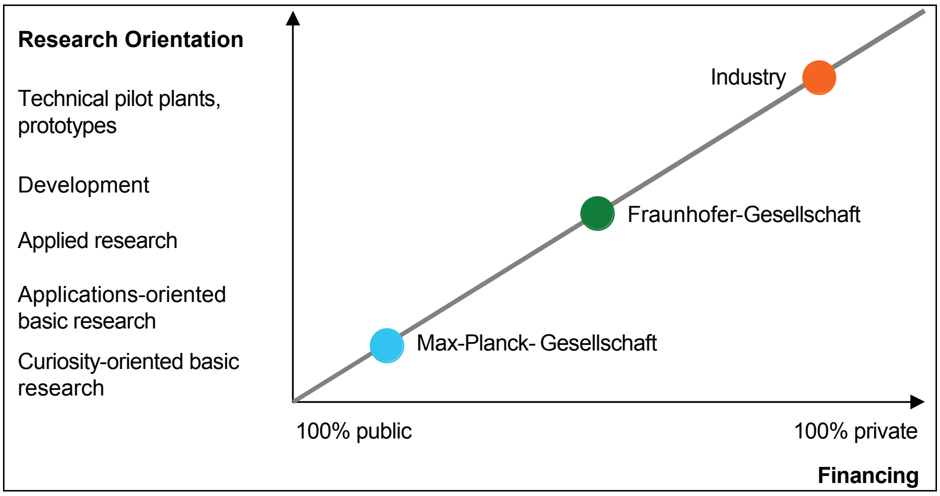
optimal arrangements as a result of the devolved and diverse structure. Yet the institutes do differentiate themselves and there is sufficient liquidity in the market to permit movement between institutes where appropriate. For example individual institutes have moved from WGL to FhG and from FhG to HGF. The drivers for such movements are not clear but are likely to do with rationalising research effort in specific research fields, having perhaps, little impact on reducing the competing activity of the different associations active in the pubic research institute sector.

***What the Fraunhofer Gesellschaft does***

It is the proportion of public funding that strictly determines the mission of the Fraunhofer Gesellschaft. The current diverse funding pattern allows the Fraunhofer to adopt a flexible position, straddling fundamental and applied research and development whilst avoiding competition with other national players (Max-Planck Gesellschaft and industry).[72] Interestingly, the main competition to Fraunhofer institutes is reported to be entrepreneurial university research departments, which can be of a similar scale (between 100-220 people) and are increasingly under pressure to generate more funds from applied research. Exhibit 92 sets out Fraunhofer's research orientation. Its role is seen in bridging and speeding up the gap between fundamental research and commercial development. Fraunhofer's core funding and its history of applied research enables it to pick up new technologies (such as molecular imaging, laser technologies and robots) early and see them through to maturity. The proportion of core funding allows them to do this. Whilst the Fraunhofer could increase the proportion of industrial income, this would fundamentally change the sustainability and content of what Fraunhofer does.

[72] Whilst there is real opportunity to expand industrial revenues in some areas, such as in wireless communications, the Fraunhofer refrain from doing so in order to (1) avoid dependency and lock in; retaining a flexible workforce and an ability to shed staff if necessary and (2) to avoid engaging in potentially state of the art research activity

**Exhibit 91 Orientation of R&D**




There is little direct government intervention or input on Fraunhofer's task. Some government influence comes in via the policy committee (government administrators) though the main influence come through the Senate (high ranking Ministry officials). The Fraunhofer is very autonomous and in a better position than some other European research organisations, which must argue ex ante and ex post for all their funding, even at a project level. Frauhofer present twice a year to the Senate and 3 times a year to the Policy Committee, composed of federal and state government.[73] Germany has a very open system with a high degree of stakeholder trust and confidence.

Fraunhofer places great emphasis on two performance indicators: the proportion of core funding and the share of industrial income in total revenues. Other performance indicators can vary from year to year and are often qualitative. The Fraunhofer's five-yearly self-evaluation is presented to its key public funders and covers management, finance, personnel, political and societal framework conditions. This 100 page document is a basis for discussion – e.g. is the Fraunhofer well positioned?  Annual reports are briefer and more operational in content.

### *Customers*

The Fraunhofer-Gesellschaft sees itself as a service company, offering its scientific and technical expertise on the market. They claim to serve small firms and large firms. About 40% of contract research for industry is for firms with less than 500 employees, about 25% is for firms with between

[73] The Fraunhofer is required to report to the federal and state governments on a range of indicators such as revenues from industry, patents, scientific publications however there are no formal targets on these and the performance indicators vary over time

500-10,000 employees and about 35% is for firms with more than 10,000 employees.[74]

Fraunhofer report few formal ‘strategic relationships’ with industry and in keeping with the devolved structure, favour a project-by-project approach managed by each institute. Some strategic research discussions with industry are reported to have been fruitless, failing early on on issues associated with IPR. In some institutes, Fraunhofer offers research space for companies to co-locate if they wish, providing ready-access to Fraunhofer research staff and a convivial research environment.

#### *Relationship with the University sector*

The Fraunhofer has long-standing cooperations with the universities. A key feature of the Fraunhofer model is the practice of nominating an institute director in consultation with a university (by preference a local university, if it can offer an appropriate chair), which simultaneously appoints the institute director to a professorship. The university, Fraunhofer or the two in combination may fund the professorships. This gives Fraunhofer access to basic research, recruitment opportunities of junior scientists and students, as well as opportunities for staff to gain scientific qualifications. Universities equally benefit from the cooperation in industry-oriented projects, opportunities for students to gain practical experience, integration of practical applications into the curriculum and common utilisation of cost-intensive equipment.

Whilst some dynamic university departments represent increasing competition to the institutes, the institutes arguer that they offer

- a broader spectrum of research;
- continuity of people;
- a mission to serve industry; and
- professionalised service delivery.[75]

### Financing and revenues

The Fraunhofer’s research is financed by three different sources: about 40% of the budget is covered by basic institutional funding, 25% is received from competitively acquired grants from national and international R&D programmes and 35% is acquired from industry. This represents a relatively well-balanced financial situation, allowing the Fraunhofer to engage in future-oriented and pre-competitive research whilst also transferring its research results to the market.

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[74] Firms with less than 10,000 employees are reported to have larger average project contributions than firms with more than 10,000 employees

[75] It is common practice for Fraunhofer to measure customer satisfaction

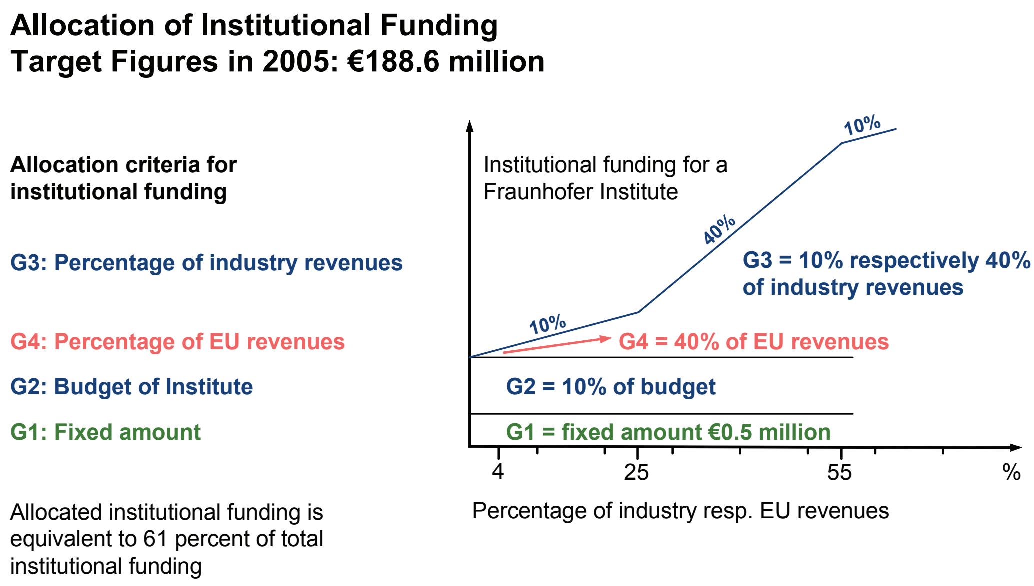
The basic institutional funding, amounting to about 380 million euros in 2005, is spilt between the federal and state governments (~90:10). There is no legal basis or contract for this support; however, due to the stable political situation in Germany the Fraunhofer is able to rely on this financing, barring small fluctuations. There is a high degree of trust and openness on both sides.

The basic funding awarded to the Fraunhofer-Gesellschaft is not tied to any specific activity and it is left entirely to the Franhofer management to decide how the funds should be allocated across the institutes. In principle, the total basic funding is split roughly as follows

- 65% of the basic funds are distributed on the basis of a defined formula whose parameters are the institute's operating budget, revenues from industry and revenues from the European Commission;
- 10% is spent on 'internal programmes' to which the institutes may apply on a competitive basis. In 2004 there were 4 such programmes, which aim at stimulating internal or international cooperation and helping the institutes to engage in new research fields;
- 10% is spent of strategic investments i.e. the purchase of new or replacement equipment. The institutes submit twice-yearly applications for these investments;
- 15% is on miscellaneous spending e.g. revitalisation of institutes with financial problems, assets for starting a new projects, relocation, special strategic projects etc.

The 65% basic funds are distributed through the formula shown in Exhibit . Each research institute receives a fixed amount of annual funding currently equating to ~ €0.5 million (G1). A second funding allocation amounts to 10% of the institute's total budget (G2). Institutes also receive 40% matching funds for EU revenue (G4). The remaining stream of funding is based on the proportional industrial revenue generated by each institute; institutes receive 40% matching funding for industrial revenues between 25-55% of the institute's total budget and 10% for less than 25% or more than 55%. This clearly acts as an incentive for institutes to operate with 25-55% industrial revenue and no more. The scale of the institutes (between 100-220 people) also restricts specialisation and encourages a broader 'renaissance' approach to research and innovation.

Exhibit 92 Allocation of Institutional Funding




## Internationalisation

The Frauhofer's international earnings have increased steadily in last 10 years. Europe remains the primary source of external funds and non-EU-Commission funding has grown significantly. In 2004, the Fraunhofer received €38 million in grants to work on EU projects valued at a total of €73 million. In the same year, contract research from European industrial clients amounted to €54 million, France being the largest source of foreign earnings. The USA has also been important. In 2004, the Fraunhofer institutes reported collective earnings of €9.1 million from American companies, an increase of 35 percent over the previous year. Third-party revenues by the Fraunhofer's American subsidiary also rose, by over 20 percent to €7.1 million.

There is no top-down internationalisation strategy and the institutes often drive developments in this area, but the central management strongly supports European expansion. Worldwide presence is perceived to be good for the home market, clearly advertising the quality of Germany's technological infrastructure and encouraging foreign direct investment. The Society has already established a presence in Sweden and Brussels and plans were afoot in 2004 to establish a research centre in Budapest. The Society also has a presence in the USA, Japan, China and Indonesia.

## Management, Strategy and Future Perspectives

The Fraunhofer Society envisages enhanced cooperation between the individual institutes. Aligned business processes should also help to leverage capacity across the association, thereby drawing on the full resource of the association in response to individual client's needs and irrespective of their point (institute) of entry.

Such consolidation and emphasis on stronger cooperation is also in line with the national "Pact of Research and Innovation" which provides additional government funds for better performance, stronger cooperation and support of young scientists across the research institutes. Specific objectives, reported in the 2004 Annual report are for

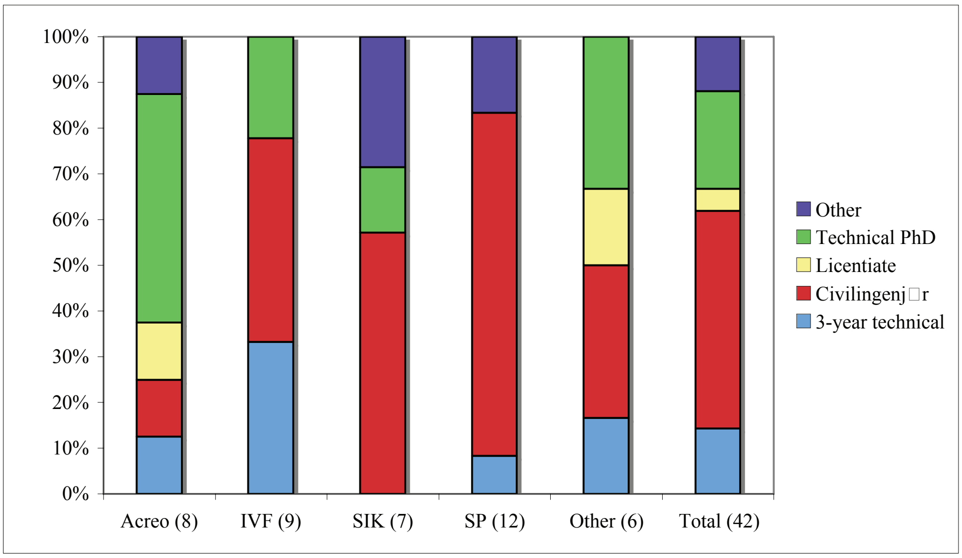
- A strategically planned R&D portfolio;
- The establishment of "innovation clusters" aiming to promote the joint development of innovative products and processes by Fraunhofer Institutes, universities and locally based companies; and
- The provision of technology-related executive training courses through the Fraunhofer Technology Academy.

# Appendix C
# Appendix to Chapter 5: Additional Materials on the Role of the Swedish Institutes

### Customer Survey

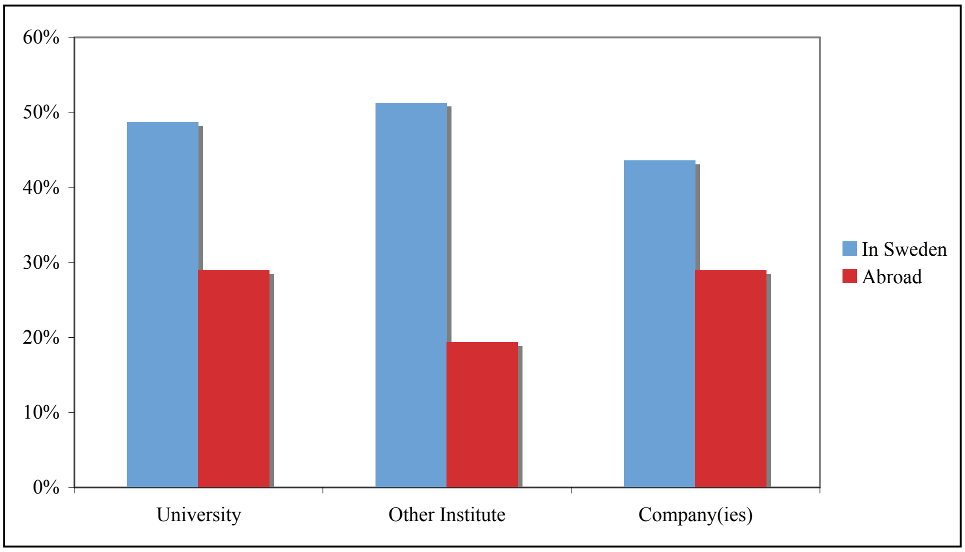
Half of the customers had a technical master's degree and a further quarter had research training (5% licentiate and 20% PhD). Acreo's customers were especially highly qualified while SP's were at the other end of the spectrum.

**Exhibit 93 Education Levels of Institute Customers**




The bulk of the projects were done in various kinds of networks (Exhibit 94). About half involved a university or another institute in some way and almost as many involved other companies. Almost half the respondents said their project involved some sort of cooperation outside Sweden.

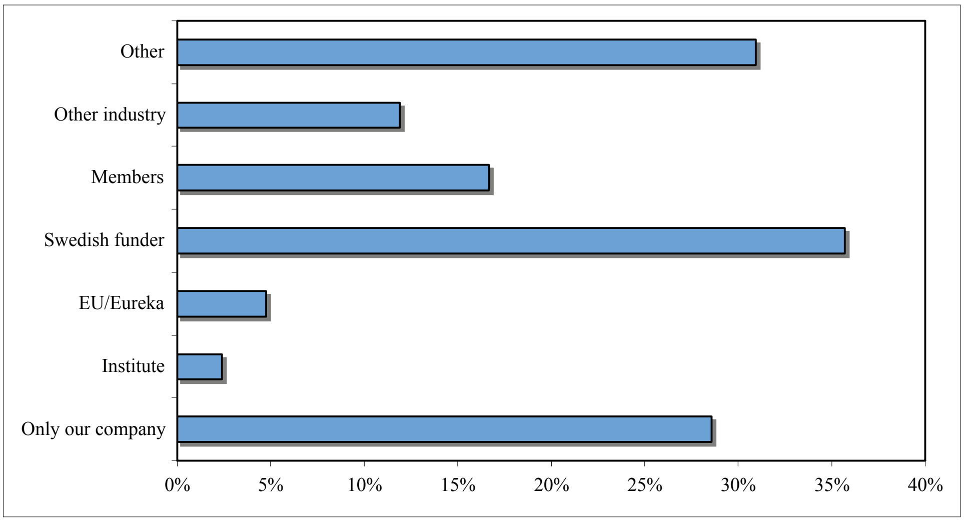
**Exhibit 94 Proportion of Projects Involving Cooperation with Other Actors**




*N = 39 for Swedish cooperations; 19 for foreign cooperations*

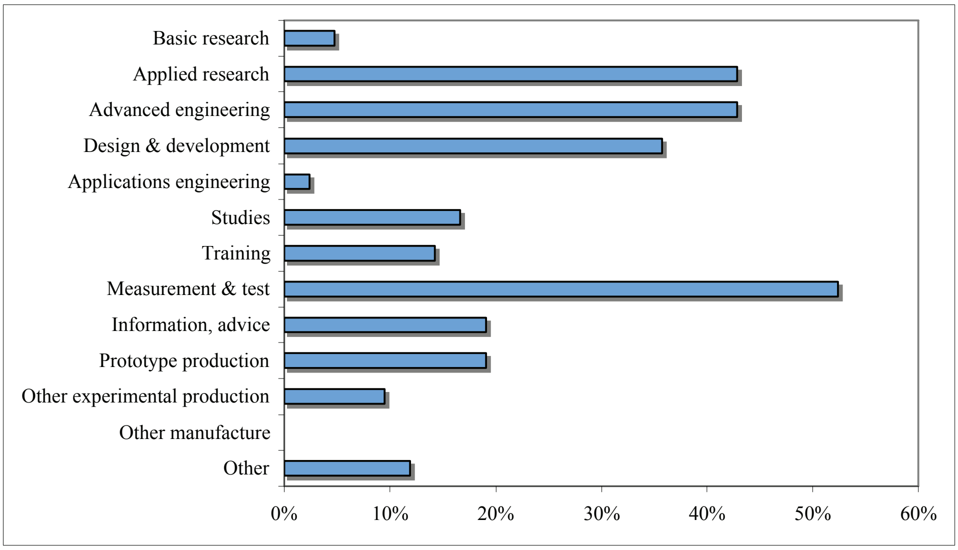
30% of the projects were financed solely by the customer's company. Agencies and foundations contribute to one third of the projects while about the same proportion involves contributions from other companies. The 'Other' category displays considerable creativity, including Nordic funding, the European Space Agency, individual companies and agencies not normally associated with R&D funding.

**Exhibit 95 Proportion of Customers Reporting Different Sources of Finance**




*N = 42*

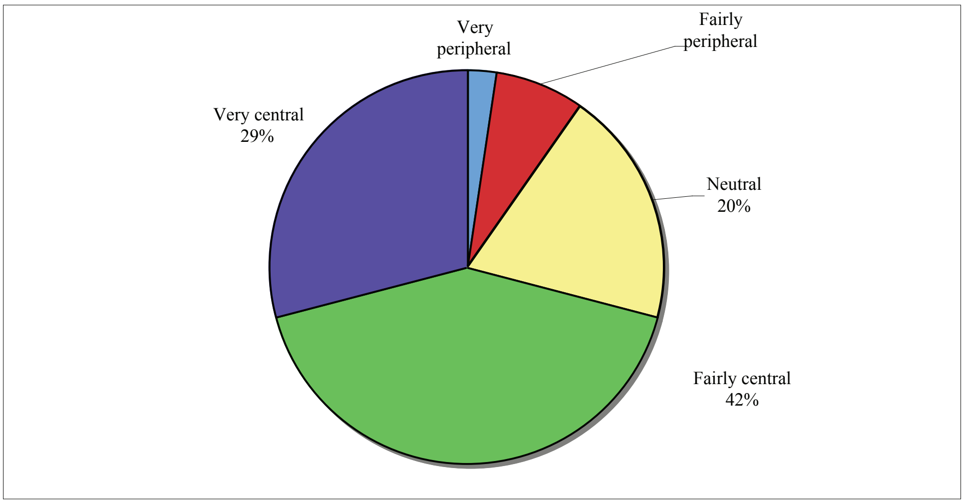
**Exhibit 96 Activities Included in the Customers' Projects**




*N = 42*

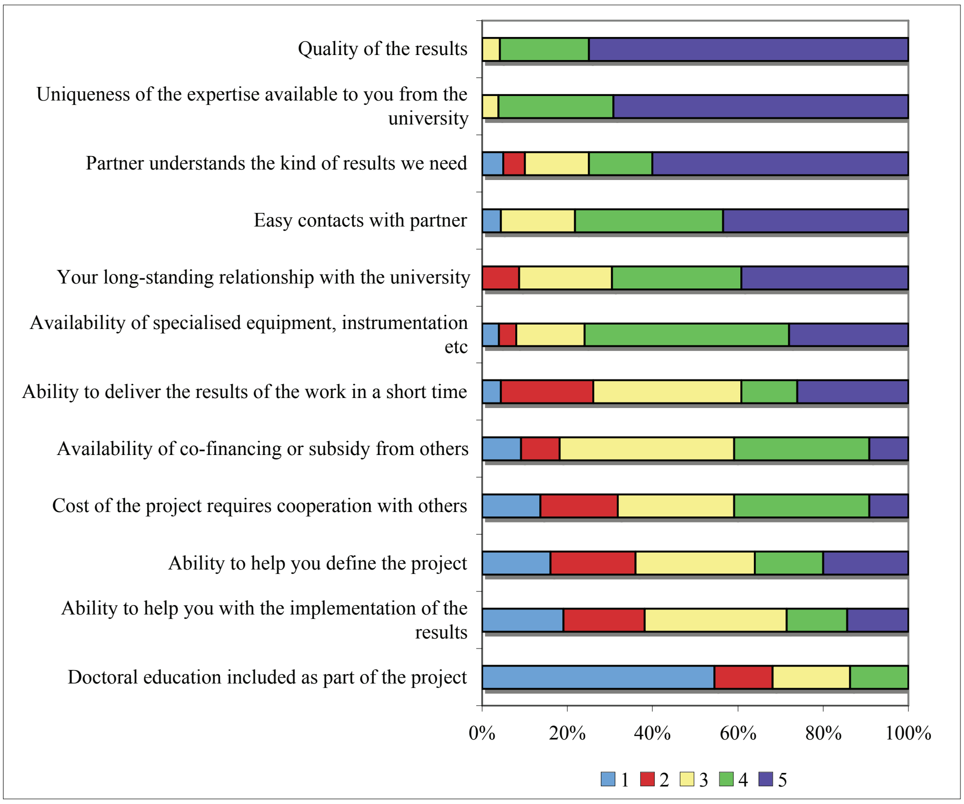
The projects were almost all close or very close to customers' core technologies. Those supported by Swedish R&D funders or members' funds were likely to be more central to company technologies than those funded by the companies themselves.

**Exhibit 97 How Close Projects Lie to Firms' Core Technologies**




*N = 41*

**Exhibit 98 Importance of Factors in deciding to Use a University (1 = low; 5 – high)**

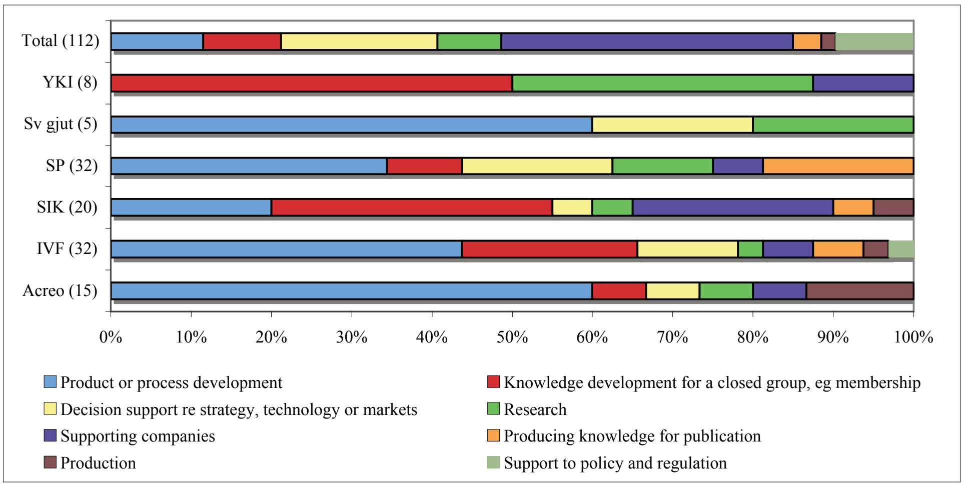



*N = 23 – 27*

Analysis of the main aims of the projects suggests large differences between the institutes in the way they work. Overall, product and process development is the most important activity, and it is more likely to be commissioned by a customer R&D department or other technical function than by management. It is also likely to be in or close to customers' core technologies and to involve the acquisition of technologies new to the company, evaluation of new designs and access to resources not available internally in the firm. SIK has a different profile, focusing more on knowledge development and other support for its members, while YKI is more concerned with producing knowledge that is input to companies' own product and process developments.

## Project Leader Survey

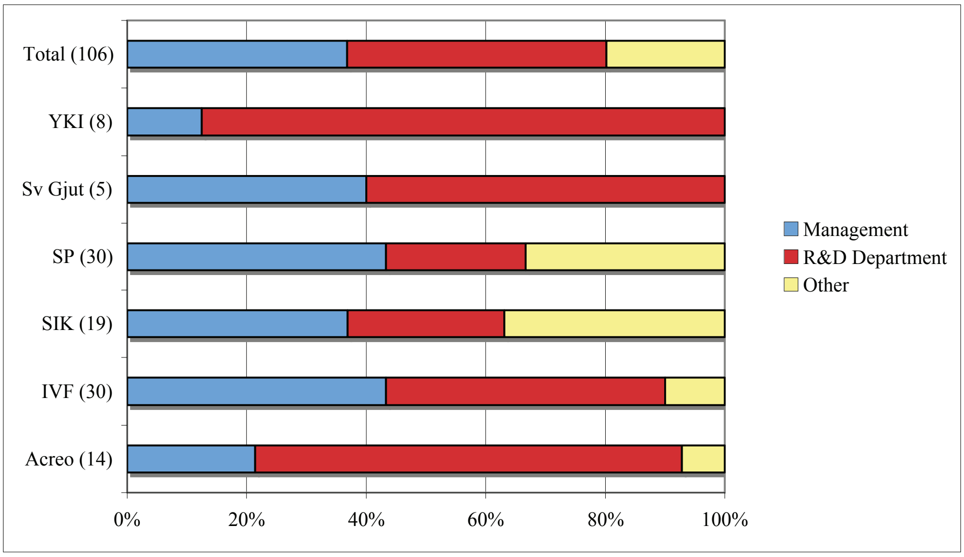
**Exhibit 99 Main Aim of the Projects**




*N = 112 in total. NB that n for SvGj is 5 and for YKI is 8*

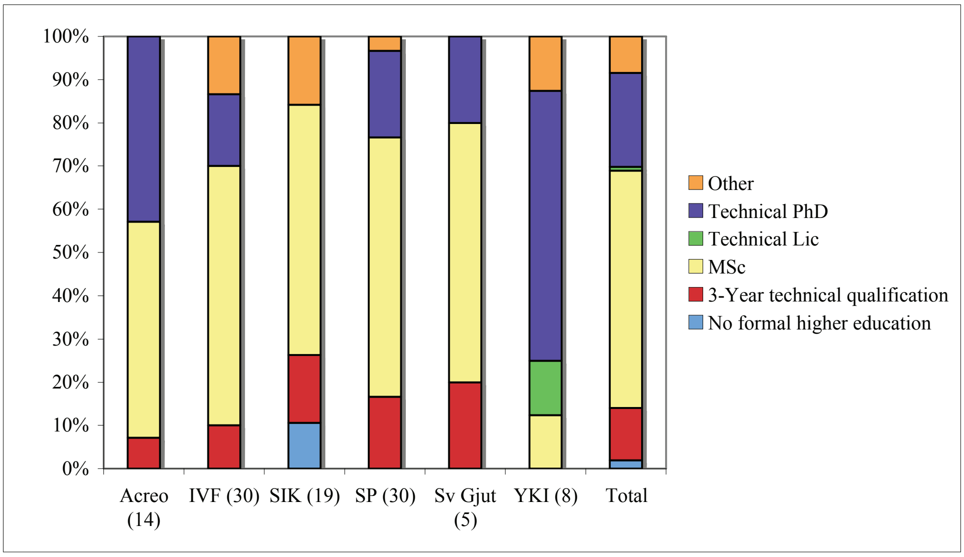
Exhibit 100 shows what the project leaders said about where their customers work in their respective organisations. Over a third work in management and over 40% in R&D. SP and SIK serve a lot of people who work elsewhere in the firm, reflecting the importance of testing, quality control and similar work in their portfolio.

**Exhibit 100 Project Leaders' View of Where Customers Work**




*N = 106*

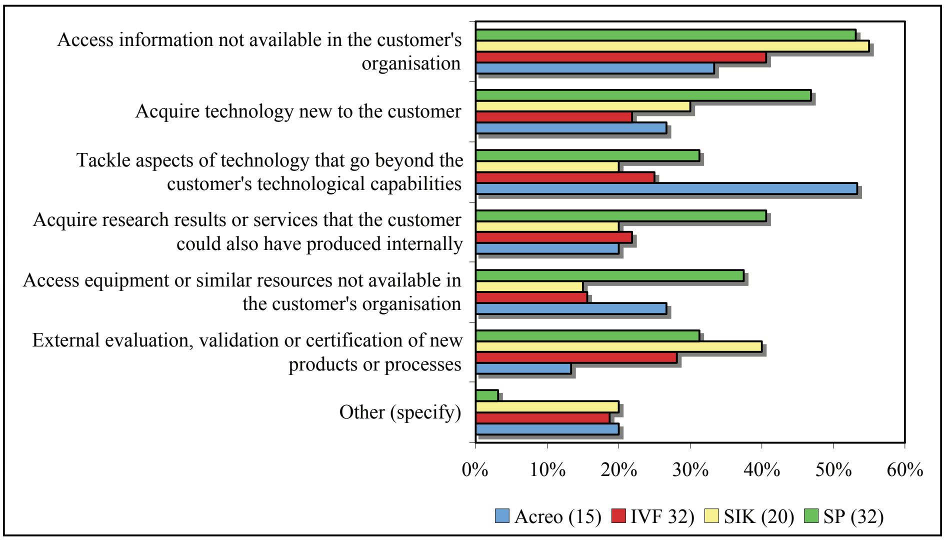
**Exhibit 101 Customers' Perceived Qualification Levels**




*N = 106*

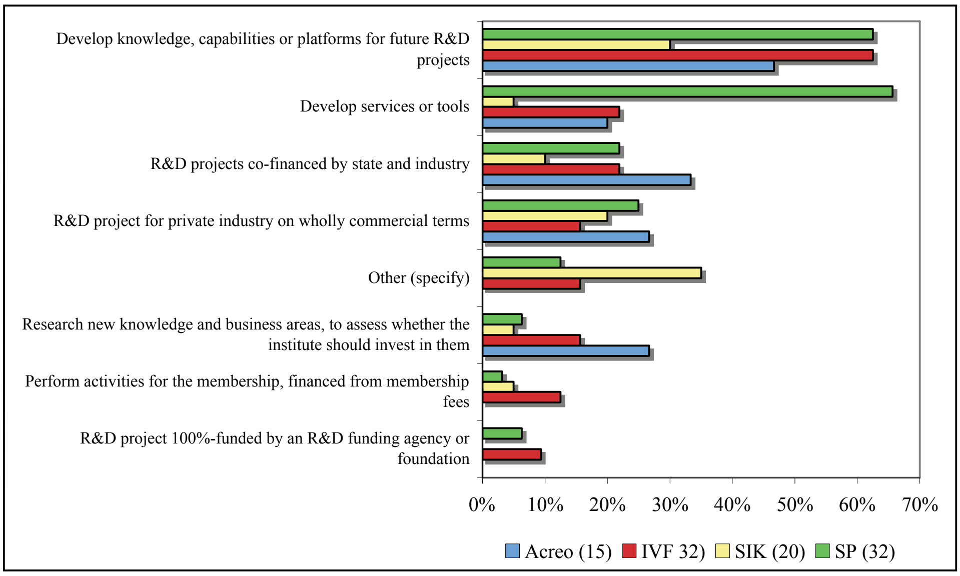
Exhibit 102 shows the variations in responses among the four institutes for which we have over 10 responses. ACREO appears more likely than the others to tackle technologies going beyond their customers' capabilities while SP is less likely to do so. However, access to facilities is much more important in relation to SP, as we would expect in an institute with its historical roots in testing and certification.

**Exhibit 102 Project Leaders' View of Customer Goals (4 Institutes)**




*N's as shown in the Exhibit*

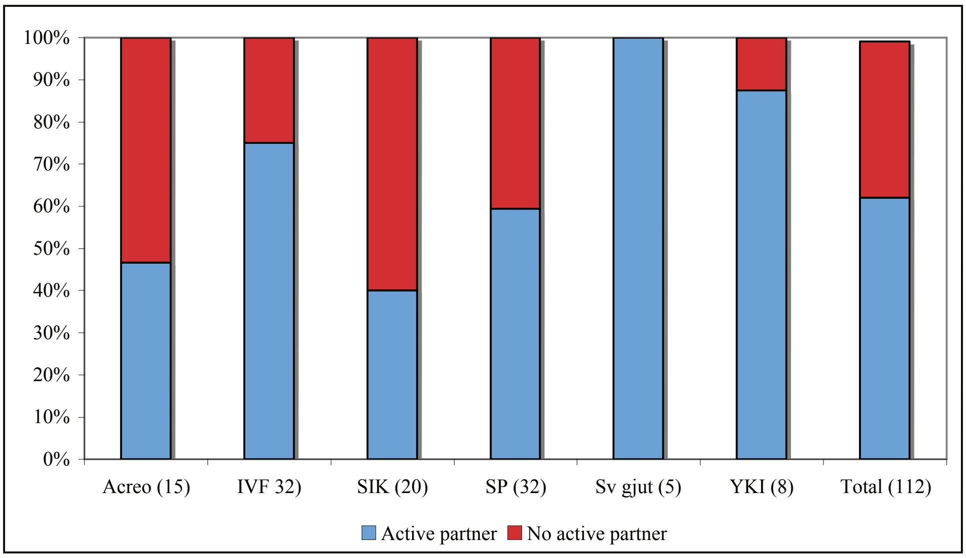
**Exhibit 103 Value of the Project from the Institute Perspective (4 Institutes)**




*N's as shown in the Exhibit*

Exhibit 104 shows that the majority of partners were companies, but that the projects were also well networked to universities and other institutes.

**Exhibit 104 Proportion of Projects with at least One Partner Active**



# Appendix D
# Three University Case Studies

## D.1 The Engineering Institute at KTH

The Engineering Institute (EI) started in 2003 as a new type of university institute in order better to match the university's competence to the needs of research and education from industry. EI represents a new way of establishing cooperation between the Royal Institute of Technology (KTH) and companies. In the beginning, Engineering Institute solved the issue of the ”third mission” for two departments at KTH, Machine Design and Industrial Production, but now does this for the whole of KTH. EI could be described as an active ”internal consultant” at the KTH, and as a service facility for the whole of the Royal Institute of Technology.

**The purpose of EI** is mainly to achieve a larger synergy between the industry and the university within the area of product development. The synergy also includes KTH's own institutions that with the help of EI will get a platform for working in cross-institutional projects.

The Engineering Institute's **business idea** is "to supply manufacturing businesses with the right competence, methods, technologies and development tools so that they them selves can develop new commercially successful products." The **vision** is within five years from the start of operations to be a recognized expert institute in the area of product development and to have participated in at least a 100 commercially successful projects in Swedish trade and industry. The Institute's **mission** is to help Sweden become a more prosperous nation by making new technology available to industry.

### Background

Engineering Institute was created in 2003 when Anders Hugnell was headhunted by KTH to become its director. To start with, Hugnell ran the Institute as en external consultant for KTH, but was later employed by the KTH for the job. Hugnell had a background at KTH where he did his PhD thesis, but on returning to KTH he had been working as an independent consultant for 10 years, much of the time helping large Swedish companies onto the European markets.

According to the EI director, the creation of Engineering Institute was not the answer to some strategic reasoning on KTH's behalf. It was more the case of KTH wanting to try something new and different, to see what it could lead to. This, according to Hugnell, explains the limited resources allocated to EI. According to the two KTH departments that were the initial EI partners, the idea behind EI was to show the possibilities to act these two departments had. The director describes EI as ”guerrilla tactics; we shoot from the hills!”.

### Organisation

The Engineering Institute staff consists of only one full time employee – the director. There is a board of seven people: two from KTH and five from different companies:

- Hans Buhre, Micronic Laser Systems
- Robin Edman, SVID
- Bengt Lindberg, KTH, chairman
- Hans Narfström, Scania
- Ulf Södergren , Assa Abloy
- Jan Wikander, KTH,
- Cecilia Nord, Electrolux

### What EI does

EI helps companies with their business-driven development by

- Putting in the right research and development resources to solve the problems. In this, researchers from KTH as well as from other leading institutes are used.
- Facilitating the latest technical equipment for verification and simulation of effects of new technical solutions.
- Taking part in product development projects.

The Engineering Institute offers the following products and services:

| Product | Time frame (effective time) | Cost |
|---|---|---|
| Degree work | 6 months | Trainee salary |
| Students, individual or in a group | 1-4 months | Normally free if it is part of a program course |
| Expert consultation | 1 – 30 days | Average hour cost 850 kr |
| Shorter ”consultancy assignments” | 1-2 months | Tender |
| Longer ”consultancy assignments” | 2-6 months | Tender |
| Shorter research assignments | 6-12 months | Tender with a subsidy if 15% of the content is academically qualifying |
| Longer research assignments | 12 months or more | Tender with a subsidy if 30% of the content is academically qualifying |
| Contract teaching | 2 weeks or more | 5 kkr per student and study point (normally corresponding to one week of full-time studies), minimum 10 persons |
| Seminars | 2-4 hours | 4-6 kkr |
| Workshops | 1-2 days | 8-12 kkr/day |
| Company networks | 1 year or more | 50-100 kkr/company |
| Use of laboratories, measurement equipment, etc. | 1 hour or more | Base cost 750 kr/hour + costs for equipment |

**Business areas**

Engineering Institute has three main areas of business

- **Competence Development**. Contract teaching within the areas of construction and production
- **Expertise for hire**. Perform short or long term R&D commissions for manufacturing businesses
- **Development tools**. To show and educate businesses in utilizing the latest software for an effective product development work, mainly within modelling and simulation

**Competence Development** consists of contract teaching within the areas of construction and production. EI offers its customers tailor-made courses, at the customer’s place or at KTH. The focus is on shorter courses of about 2+2 days, with delivery six weeks after the order is made. As EI is part of the proDesign network, they can also offer courses from other Swedish universities.

Some examples of courses: Module division of products, Industrial design as an element in modern product development, 3D-Cad as a visualising tool, support tools in modern product development, production simulation, Eco-design, and Efficient use of new materials.

In **Expertise for hire,** EI carries out longer or shorter R&D assignments for production companies. EI has a pool of experts in areas concerning construction and production, and the client can hire an expert for a shorter or longer period of time when the need arises. EI also offers to find the client the expertise in other departments of KTH if there is a need for different competence.

**Development tools** is about showing and helping companies to use the latest software in order to be more efficient when bringing out new products, especially in the areas of modelling and simulation EI carries out longer or shorter R&D assignments, preferably such assignments that are in the frontline in order not to compete with existing consultancy firms.

EI has no direct scientific production of its own. It exists in an indirect form, in the prolongation of assignments, but not to any larger extent. EI uses degree students or PhD students for parts of some projects. The EI director describes all of it as a “tool box”, out of which different tools or combinations of tools can be offered when visiting prospective clients and selling the EI concept. The director points out that EI is very clear in all these contacts about charging for their services, and EI does not try to sell projects by offering, for example, possibilities of co-financing through other projects.

#### Clients

The main beneficiaries of the results are companies in manufacturing industry, mainly small and medium sized businesses. The service provided to bigger companies has a more theoretical content. EI works with some 20 projects at any given moment, above all in the areas of production and product development. The institute also takes on shorter contract teaching assignments.

The university will also profit from the results. A first step is to form a centre according to KTH’s model and then in the next step cultivate a new organizational form that will better match the university’s competence with the needs of the industry.

Some of the clients over the last 12 months are the following: Bosch Rexroth, Elekta, ABB, Kompositprodukter, SQS (now Cashguard), Berotec, Svea Juridiska, Mydata Automation, Åsbergs Mekaniska,Bacho Tools, AGA AB, Skelleftekraft, Dometic, IVA, ASSA AB, Sunfab, Silva, Modellteknik AB, Ortolab AB, Gernandt Advokatbyrå, Spectrogon AB, Rocker Produktion AB, Ljusdesign AB, Skärmteknik AB, Elektrosystem AB, Alvenius AB, Phasein AB.

#### How the Engineering Institute works

A typical EI project runs for about 1-3 weeks, in effective time. The project is initiated in one of these four ways

1. A seminar on a subject of current interest (for example, lean) Follow-up with phone calls, visits and project formulation
2. Through the external relations office of KTH
3. Through an employee at KTH who knows about EI's activities
4. Through the EI director's personal network

In the beginning, most contacts were initiated by the EI director. As time has passed Hugnell's network has become big, and the most common form of contact nowadays is clients getting in contact directly with him. This form covers about 30% of the total number of contacts. The other three contact forms are all fairly similar in size.

Generally speaking, a cost of around 100 kkr for EI for a new project is typical, in a time frame of about 2.5 weeks' effective time. The EI director himself largely handles project management.

The scientific and technical know-how of the collaboration partner is, as a rule, very high. These are often technical doctors, and require EI's services because they lack a specific competence. The client's knowledge and capacity of implementation is usually less, and here EI often ally themselves with consultancy agencies in the same way as these players look for EI's specific competence in a certain area. The EI director is at present involved in talks with one of the main consultancy agencies in the area, åF, about developing a more long-term collaboration.

EI usually has about 20 projects rolling simultaneously. Since some of the projects do not get off the ground, an estimate of the total number of projects started in the year 2005 would be about 30. The clients usually have very vague ideas of what the EI capacity is and what EI can do for them – EI have access to a wide variety of specific knowledge, as well as various kinds of equipment. EI can also help clients with technology verification through modelling and simulation, which is useful before going further to produce a finished product.

EI has only one employee, but about 80% of the assignments are carried out by KTH employees. The agreements are signed between the client and EI. In practice, it is the EI director who designs and prepares the business-side of the collaboration, and the director then hands out the payment to the department where the researcher in question works – not to the researcher as a person. In this respect, the EI director is the only person the company has to deal with.

#### *Two examples of acting as an intermediary*

The initiative to collaborate with a KTH department usually comes from EI. The usual pattern is that a company gets in contact with EI when an emergency situation appears. The Department for Industrial Production, for example, do not go to EI to ask them to act as intermediary to companies; mainly because the department themselves have very good industry relations. Not all company contacts go through EI, as many companies make their requests directly to the department. The dilemma for the department is finding the right people at the department with the time and willingness to take on an external assignment. There needs to exist some spare capacity at the department in order to be able to take on small projects, and not all researchers are equally interested in the idea of working together with a company. For these reasons, the department sometimes turns down offers transmitted by EI.

At another KTH department, Machine Design, almost all company contacts go through EI. Before the creation of EI, the contacts with industry went through the research, and the assignments then were of a different character. With EI, there are more direct assignments; the projects are more of a problem solving kind. As a rule, the contacts with industry the researchers had before were through large-scale projects – and, as a consequence, with large companies. With EI, this department has entered in contact with SMEs, entrepreneurs and inventors with bright ideas.

A ”typical” EI project for the Department, of Machine Design looks like this: The EI director talks to the client, and then the three parties meet. They try to find an appropriate and well delimited first part, in terms of time as well as money, with a maximum sum. If the client then is satisfied, the project is continued and amplified. For this reason, the initial projects are small: typically a couple of weeks (sometimes even down to only a few days) and with a budget of 50-150 kkr. In most cases, only these three players are involved in a project, although sometimes another person from the department with a particular competence might be brought in. It is rarely the case, though, that more than one person from the department takes part in the same project.

### Relations with the university sector

The collaboration between EI and the departments at KTH is on a project to project basis, and there are no long-term agreements or obligations for any of the parts. Engineering Institute has no PhD students or tutors.

### Financing and resources

Today, EI financing consists of some 70 % from industry and about 30% from public funds (Innovation Bridge, ALMI, NUTEK, Vinnova). KTH does not finance the EI at all. The Engineering Institute is formally a research centre, and at KTH these as a standard get 500 kkr a year for their first three years – and then KTH stops financing them.

EI has no resources in common with KTH. The director points out that he, like everybody else, can rent or hire specific equipment or premises when there is a need for that.

EI income has increased steadily over the years, as the following table demonstrates.

| Year | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|
| Income (kkr) | 500 | 1 000 | 2 000 | 3 500 |

### IPR

None directly under EI. There has been some as a consequence of some of the assignments, but to a very limited degree. However, this is not goal in itself for EI at the present, since there are no resources to run these issues. The ambition is more to direct and guide incoming requests to the right person in KTH; EI has the knowledge of where the resources to further develop ideas can be found.

A representative of one of the KTH departments comments that company collaboration through the mediation of EI has given a significant spin-off in teaching – through these real-life cases, you can relate to real situations, and the more contacts you have to real applications, the better your ideas for teaching become. These collaborations can even give rise to exam questions.

**I** seems probable that the activities carried out by EI will be lifted up and become a subsidiary or a foundation under the holding company. The EI director Anders Hugnell sees this as an opportunity, on the condition that he will be able to keep the board and the control of the institute. This solution would mean better resources for this work, and the director would be able to dedicate more of his time to more strategic matters.

If, on the other hand, EI organisationally remains as today, the ambition is to double the turnover and to hire one or two project leaders in one year, in order for the director to be able to dedicate more time to strategic issues and marketing. The problem is not to find projects, but to channel them out in the KTH organization. EI needs to improve its pace; if it due to lack of resources takes several weeks to find the right person in the organization, the client loses interest.

The long-term basic financing remains fundamental, and constitutes a threat to the activity. According to the Engineering Institute director, experience says that an activity of this type requires basic financing of around 30%, from KTH or from somebody else.

## D.2 Chalmers Industriteknik (CIT)

Chalmers started Chalmers Industrial Technology (CIT) as a foundation intended to promote more efficient use of research in commercial development initiatives. This is a self-financing entity which has been working for 20 years to make Chalmers' full range of skills and other research resources available as a basis for commercial ventures on behalf of Swedish and foreign clients. CIT's aim is to initiate, organize and carry out projects where Chalmers' competence is made useful in trade and industry development processes. For areas of activity where there is a permanent market base, the foundation forms dedicated companies to make more effective use of the knowledge obtained.

CIT presents itself as a ”university-based institute”. This means a clear focus on the client for the development of research results produced by university and industry. The difference between the university-based institute at Chalmers and a more traditional institute, according to CIT, is that the CIT institute is a foundation with a clear definition of its objective:

> *The objective of the Chalmers foundation for technical and industrial development is to ensure efficient, high-quality and appropriately large exploitation of CTH's capabilities and resources for research and development contracts in the service of industry and sector agencies. The foundation works on a commercial basis and must cover its own costs.*
> (From the Chalmers Industrial Technology (CIT) statutes,1984)

The focus on the client is emphasised, and this sometimes requires co-ordination of R&D from other universities.

### Vision and mission

CIT shall create economic and other added values for clients in need of the full potential of a technical university. CIT carries out qualified and efficiently led assignments of investigation, development, construction and consultancy work with its own or Chalmers' scientific staff and physical resources. This means that CIT

- Makes the investigation useful directly in the companies' many-layered technical development processes,

- Quality-assures Chalmers' industrial engineering competence for an increased economic growth, and
- Prioritises timeliness in the industrial processes.

The CIT **vision** is to be an efficient commercial link between trade and industry and university, and to be a nationally leader in multidisciplinary application and further development of research results. Its **mission** is to refine the strengths of the university and the companies into concrete business advantages and increased competitive edge for all parties concerned. The following components are included in each of the development projects carried out

- Development/technology
- Project management
- Market analysis and marketing of new technology
- Project refinement and sales
- IPR

CIT's **objective** can be summarised as follows

- Focus on researcher-close development projects, formulated together with the research groups with the aim to solve present and future industrial challenges
- Employment of commercially interested doctors in relevant development areas close to the researchers' core areas
- Funding through direct client assignments and public programs favouring development

#### Core areas

CIT describes one of its strengths as generalism: "our speciality is being non-specialised". This helps the CIT direct the right resources in the projects they run on behalf of their clients, regardless of the scientific disciplines involved. There are, however, some areas where CIT is especially strong

- Environmental technology
- Energy optimisation of buildings
- Industrial energy and process optimizing
- Combustion engine technology
- Fluid dynamics
- Systems technology
- Micro- and nano technology
- Corrosion

### Organisation

The board of Chalmers University of Technology appoints the CIT board and accountants. The board members represent trade and industry as well as university.

### Board

| | |
|---|---|
| **Stefan Bengtsson** | Prof. Chalmers University of Technology |
| **Anders Brännström** | CEO Volvo Technology Transfer Corporation |
| **Johan Carlsten** | Pro Vice-president, Chalmers University of Technology |
| **Jack Forsgren** | Former CEO Nobel Biocare |
| **Thomas Hjertberg** | Prof. Chalmers University of Technology |
| **Bjarne Holmqvist** | Chairman, former CEO Gunnebo AB |

### Staff

With its four subsidiaries, CIT has a staff of 27 full-time employees. Two thirds of the staff has a doctor's degree. The table below indicates that the CIT staff is very highly qualified, with an unusually high level of PhD employment

| Qualification | Number of staff | Share of staff |
|---|---|---|
| PhD | 18 | 67% |
| Licentiate degree | 3 | 11% |
| Business school graduate or Master of Engineering | 5 | 18% |
| Unspecified | 1 | 4% |
| Total | 27 | |

About 60% of the staff has been headhunted from industry. CIT considers it a prerequisite for the staff to know about the conditions and demands of industry in order to be able to function in this role.

CIT also takes on newly graduated doctoral students from Chalmers, when a need arises to strengthen certain competences or strengthen the relations to certain departments at the university. However, it is not the specific professional knowledge that decides whether to hire this person or not; CIT emphasizes that the staff they hire must have a strong wish to work in close collaboration with industry and have an ability to sell. Before being engaged, these newly graduated doctoral students have been tested in "sharp" projects.

**Subsidiaries**

CIT has started and run several subsidiaries in areas where the market demands more specific competence. The subsidiaries are independent legal entities and joint-stock companies, and are in charge of those projects that turn out to be repetitive. Collaboration with industry usually starts with a pre-study, and when this gives rise to a more long-term relation, the collaboration is transferred to one of the CIT subsidiaries.

These companies attract money to Chalmers; a professor could, for example, link a development project to research project. The CIT subsidiaries have positive cash-flow, which is important when dealing with risk management; they provide CIT with a buffer. The subsidiaries buy services from Chalmers, with a varying margin. Sometimes the margin is 0%, but usually about 10%. In those cases where the margin reaches some 40% in the project, some 20-30% usually goes back to the university department.

Some of the CIT subsidiaries have a staff of up to ten people, whereas others consist of the CEO only. The distribution of the staff between CIT and its subsidiaries is ass follows:

| Chalmers Industriteknik | Staff |
|---|---|
| CEO + CIT project leaders | 9 |
| Senior advisers | 2 |
| CIT Ekonomiservice AB | 1 |
| CIT Industriell Energianalys AB | 4 |
| CIT Energy Management | 10 |
| CIT Thermoflow AB | 1 |

**CIT Industriell Energianalys (CIT IE)** is a consulting and development company with its origins in the Chalmers chemistry and energy research. CIT IE collaborates with its clients in systematic analyses of complex energy systems and energy technologies. The analyses identify economically and functionally favourable solutions, highlight consequences of different development alternatives and suggests action plans and decisions.

**CIT Energy Management AB** has the ambition to be a leading company in questions concerning energy efficiency and indoor climate in all types of buildings. The services apply before a building is projected as well as in existing buildings.

**CIT Thermoflow AB** carries out research, consulting and development assignments in the areas of gas, particle and fluid currents. They are specialists in urgent problem solutions, damage analysis, measurements and competence development programs.

**CIT Ekonomiservice** offers its services to small, often newly established, technology-based companies with services ranging from accounts to administrative company issues.

Previously, there was a fifth subsidiary, **CIT Ekologik AB.** This company has closed down, and its activities are now carried out by the research institute IVL.

### What CIT does

Chalmers Industrial Technology (CIT) offers three basic services that could be hired separately but are naturally linked to each other. The three services are **Pre-study, Product and technology development** and **Knowledge support**.

The **pre-study** starts with a discussion with the client in order to identify problems and possibilities, and to delimit the clients' wishes, needs and expectations. The pre-study is a way of exploring existing possibilities and valuing the new alternatives that new technologies make possible. **Development projects** are often initiated as a direct consequence of a pre-study. If not, CIT start by mapping the clients' problems, needs and possibilities. This mapping phase typically takes less than one day.

After that an inventory is carried out to see which people and what resources the project requires. If Chalmers' own resources are not enough, experts from other universities can be engaged. This process is carried out in close collaboration with the client.

CIT then deliver a project plan, including a tender and a time schedule. A project leader is appointed, and this person will then function as the clients' connection to academy. The client could at this point choose to hand over the management of the project wholly to CIT, or let its own staff work side by side with the Chalmers researchers and thus improve its own competence. The implementation of the project results is done solely by the client. CIT can also take on issues raised in the project concerning patents and rights.

CIT **Knowledge Support** offers its services to companies in technology driven sectors aware of the need to follow the technological development in order to stay competitive. By using the knowledge inherent in the CIT network, these companies get a unique possibility to predict future developments in a certain sector. Knowledge support could also mean education programs, surveillance of issues concerning patents, immaterial rights and relevant European Union legislation.

### CIT's relation to Chalmers

Technically, CIT is an independently run foundation, with its own statutes. In practice, however, the autonomy is rather limited, by the above quoted paragraph and by the overarching goals of Chalmers. The CIT CEO affirms that they always check sensitive issues with its board members from Chalmers. In practice, CIT complements Chalmers' activities in various ways

- Through proactive company visits (some 150 visits/year)
- Follow-up and contacts with previous clients (some 200 a year)
- expansion of activities directed to strategic areas (these are defined together with different groups within Chalmers)
- direct development-oriented collaboration with the research groups and the companies
- CIT help the national innovation system with direct efforts in development projects that could become future companies
- CIT help research groups with operative aid in dialogue with med EU officials and other companies that operate internationally

A fifth of the CIT turnover consists of projects with Chalmers departments. Here, the agreement is signed by CIT and the department, and not directly with the doctoral student or researcher carrying out the assignment.

### Clients and projects

Ever since its inception. CIT has worked mainly with big companies. They have especially close relations to big corporations in the Gothenburg area, such as Volvo, Ericsson and SKF. The CIT target group has now widened, especially in a geographical sense. CIT now emphasize SMEs in their outreach work, since CIT consider that the large companies have their own channels and contacts to Chalmers. A company like Volvo, for example, turns to CIT only when issues require strict secrecy.

The following is a list of some recent clients and projects.

| Client | Project |
|---|---|
| Petroleo do Brasil | Study on anchoring forces for oil platforms |
| Greenpoint Chemicals | Analysis of petrols and allocation to environmental categories |
| IBM | Analyses of inks and raw materials for inks |
| Volvo Cars | Analysis of combustion emissions and calibration of test equipment. Noise emissions from panels. |
| S.E.Tech Corp & San Eisha Co Ltd | Materials development for aerials and thermistors |
| Autoliv | Proximity sensor for crash system |
| Astra Hässle | Extraction of substances with pharmacological properties |
| Saab Ericsson Space | Corrosion analysis of control computers<br>Analysis of the materials properties of electronic enclosures |
| Ericsson Mobile Communications | Sound quality in mobile phones |
| Saab | "multiplex car electronics" |
| European Commission | scientific expertise in the field of aircraft propulsion |
| Swedish Medcom | Flow optimisation of cannulae |
| ABB | Particle separation from diesel exhaust gases |
| IKEA Trading und Design | Analysis of process efficiency improvements |
| Volvo Foundations | Coordination of Future Urban Transport conference |
| Volvo Aero | Future space planes |
| ABA of Sweden | Stiffness and flow analysis of new types of hose |
| SQS | Technology and systems analyses for quality-assured production of portable safes |
| The Swedish Rescue Services Agency | Alarm systems for nuclear power plant |
| Cleanosol | Reflective road markings |
| Saab Barracuda | Signature adaptation |

**Relations with other research institutes**

The CIT CEO has a background in the petrol industry, the pulp and paper industry and academia. He claims it is difficult today to compete on equal terms with the research institutes. He also says that, when necessary, he would like to be able to buy the services from the institutes, but that this is not possible today. If a project ends up at one of the institutes, these do not always collaborate with the others. CIT collaborate to a limited degree with other Swedish institutes, and also do it through their participation in the KK Foundation-funded Forestry program at the Mid Sweden University.

What is needed is to find possibilities for coordination with the research institutes. CIT entered IRIS for this reason, as they realized they did not know what competences the other institutes had. Another research institute, IMEGO, express the situation in a similar fashion; IMEGO claim that CIT and the institutes are mutually dependant, and only when they start working together will they really come to see what competences and capacity the other possesses.

Interviewees from other research institutes claim their role is different from the one of CIT. CIT acts more as an intermediary of contacts between the companies and researchers at Chalmers, whereas IVF and IMEGO are closer to and work directly with the client. This, however, is not a picture the CIT CEO recognizes; he points out that the greater part of the CIT turnover corresponds to direct client assignments, and for which they can estimate the product value. Most institutes, according to CIT, depend on big project funding from entities such as VINNOVA.

The other research institutes conclude that CIT has an important part to play, but mainly in relation to those companies or other players that do not have direct contacts into Chalmers. CIT has an intermediary role, and when this intermediation is done the role of CIT becomes less important. ”CIT does a great deal of good – but not for us!”, as the IVF CEO puts it. In later years, IVF has collaborated with CIT to a very limited extent. This research institute has good personal contacts at Chalmers, and thus cuts short CIT’s potential role.

#### Funding

CIT started in 1984 as a foundation. The initial capital came from industry, and especially from big companies in the Gothenburg region. The contribution from Chalmers to the start of the foundation was very small, almost symbolic (1 000 SEK). CIT’s capital today is about 25 million SEK.

CIT have no base funding. The turnover is in its totality the factual activities carried out – 80% of which consist of client-funded projects, and some 20% are assignments from Chalmers. In 2005, the turnover was 39 million SEK, compared to some 3 million SEK at the start in 1984 and some 11 million SEK in 1998.

Apart from this, research at Chalmers to the amount of 21 million SEK is funded through the CIT activities, although this does not appear in the CIT accounts. This is done through tutoring of doctoral students and coordination of research programs.

#### IPR

The IPR issues have to be considered on the higher Chalmers University of Technology level, since CIT is a part of an overall Chalmers Innovation Systems (CIS). This system includes seed-financing from Chalmersinvest, start-up of companies and advanced business training at Chalmers School of Entrepreneurship, company support (incubation) from Chalmers Innovation, commissioned research through Chalmers Industrial Technology and leading-edge research in the field at the department of technology management and economics.

Advanced research and development is organized through the joint Center for Intellectual Property Studies (CIP) with a view to reinforcing the existing innovation system and helping to build a stronger infrastructure for the handling of innovations. CIP Professional Services is organized in three different integrated departments supporting innovation from the most fundamental supporting platform level and early stage to market introduction and beyond.

**TTO and innovation platform design – creation, capture and evaluation of innovation and network assets from knowledge resources.** CIP can support its customers in building the highly sophisticated structures needed for efficient technology transfer, complex R&D collaboration and licensing, and open innovation. The department primarily directs its services to universities to support building the fundamental structures stimulating the creation of innovative ideas, capturing and packaging them, evaluating them and finally transferring them into society via the most suitable vehicle. However, CIP has also been engaged or consulted by public institutions and science parks, where focus has been on creating platforms for open innovation or R&D collaboration. Large corporations may also be a conceivable customer.

**Intellectual asset/property/capital management – creation of innovations, markets and capital from innovation and network assets.** This department is based on CIP's core research in identifying and understanding how innovations, markets and hence in particular value is created in practice from intellectual assets, such as ideas, technical functions, design, brands etc. The department focuses on the actual process for turning intellectual assets into financial value.

For universities it will help to operationally package, choose the right commercial vehicle for and design the business model around the intellectual assets gathered by the innovation system to transfer them onto the market. In the industry sphere it helps business ventures of all sizes to maximize value extraction from their R&D and inventions as well as develop the right organization and capabilities for long-term success.

**Intellectual Property Rights Management and Legal – essential supporting service.** The department of IPR management and legal is built on the in-depth understanding of IPRs and legal tools as a necessary fundament for all research and education at CIP. The services include patent and trademark management, portfolio construction, contract review and negotiation, legal issue spotting etc. These services are all essential in the construction of knowledge-based business and will be offered almost solely as complementary to the services offered by the other two departments and in particular the department for IA/IP/IC management.

#### Strategy and future perspectives

The future ambition of CIT is to refine the development process beyond research, by means of verification of development processes and in services and prototypes. This, according to CIT, will strengthen the research and create a win-win situation. CIT has identified EU funding as an important aspect for the future. Today, CIT are involved in 128 running projects at the EU level, with a total budget of 37, 5 million Euros. Strategic collaboration with Chalmers University of Technology in order to further develop near-research development processes is estimated to be able to double the EU funding.

CIT defines its targets for the year 2015 by comparing with the results of the fiscal year 2005.

| | Fiscal year 2005 | Fiscal year 2015 |
|---|---|---|
| | Globalisation started | Globalisation finished |
| Turnover | 39 MSEK | 370 MSEK |
| CIT's contribution to the Chalmers group | 21 MSEK | 200 MSEK |
| Estimated worth for client | 1000 MSEK | >10000 MSEK |
| Result | 2 MSEK | >20 MSEK |

## D.3 Casting Innovation Centre (CIC)

In February 2004 a collaboration agreement was signed between the Swedish Foundry Association and the Jönköping University of Engineering to set up the Casting Innovation Centre (CIC). The aim was to create an internationally strong research and education environment for the truck, car and manufacturing industry within cast material.

The **vision** of CIC is to create a national initiative of world class research, development and education for the Swedish truck, car and manufacturing industry within cast material, processes and components. Casting Innovation Centre will constitute a well-recognized organisation acting on an international market, strongly involved in research, development and education within the areas of product development, production/processes and materials for the casting/foundry industry.

#### Background

The Swedish world leading automotive, telecom and engineering industries require world class R&D and training in foundry technology. This area has a long tradition in Sweden in education and research, and in order to maintain and improve this situation it is Casting Innovation Centre's ambition to renew the working methods and to help the industry find innovative solutions to complex phenomena. Thanks to its strong industrial support, the centre has good possibilities to become successful nationally as well as internationally.

Collaboration on a project to project basis has existed for quite a long time between the Jönköping University of Engineering and the Foundry Association. When a special chair for casting technology was created at the University in 1997, this collaboration started to include research issues.

The chair was financed by the Swedish Foundry Association together with Volvo and Scania. The professor, Ingvar L Svensson, was taken from the Royal Institute of Technology in Stockholm, and the chair located to Jönköping since that was where the Foundry Association was based. In parallel to this build-up of competence at the University, basic research was also carried out at the Swedish Foundry Association. This duplication was considered inefficient and led to the creation of Casting Innovation Centre.

### The creation of Casting Innovation Centre

It was clearly industry (Volvo and Scania) who pushed for the creation of CIC. The professor describes CIC as an effect of wanting to keep a doctoral student employed at Volvo as a part-time university researcher after finishing his thesis. The company agreed to this, on the condition that some other company, preferably the main competitor Scania, also joined the collaboration. The CIC collaboration then started with a few projects, and as it has developed it has continued to be basically project-oriented. Today, there are two main projects, of 18 and 25 million SEK each.

The Swedish Foundry Association considers the creation of CIC as a natural step; the CIC agreement was a strong indication of these players' wish to work closer together. From the University, the driving force behind CIC is described as the need for better coordination. The collaboration with the Foundry Association was poorly coordinated, with weak commitment from many quarters. The Foundry Association, furthermore, lacked top notch research.

### Organisation

The Casting Innovation Centre collaboration is formalised in an agreement that clearly states how many man-hours each participant is to put into the collaboration. The agreement also contains project plans, describing who does what and when.

CIC is managed by a steering group of four people: the managing director of the Jönköping University of Engineering, the professor of cast metal technology at the same university, and two representatives from the Swedish Foundry Association. The steering group is mainly a forum for information and coordination, but it is here also that investments planned by any of the participants are discussed. The reason for this is to coordinate resources, and avoid investing twice in similar equipment.

The decisions in the individual projects are made at project level. Ultimately, it is the companies who run the collaborations and make the decisions in the projects, and it also people from the companies that hold the function as chairman for each steering group at project level.

The head of CIC describes it as a virtual organisation, where people and resources are allocated according to needs that occur. There is no centralised organisation or administration of the CIC. For Jönköping University, all collaboration with CIC is done through PhD projects.

Two employees of the Swedish Foundry Association are CIC PhD students, spending at least 50% of their time at the University. Their salary comes from the Foundry Association, which also pay a small amount to the University for the tutoring. There are another three industrial PhD students connected to CIC, two at Scania and one at Daros.

Marketing of the CIC has not been high priority. The marketing that has been carried out has been done separately by the participants; no common activities have been made.

#### What the Casting Innovation Centre does

CIC is described as a competence centre. Collaboration with industry is carried out in projects where separate agreements are signed. Today, some 40 researchers work within CIC, out of whom 15 are doctoral students from the Jönköping University of Engineering.

The centre is able to perform research programs or projects which deal with the complex and multidisciplinary casting process with disciplines such as fluid dynamics, heat transfer, material science, materials mechanics and computer simulation. Globalisation creates a need for more focused and product oriented research and development activities. Consequently, in order to have competitive products the manufacturing process has to involve the latest technologies and make use of advanced knowledge.

The research focus is on integrating the entire production chain, from design and product development to finished product. This includes the use of simulation for virtual prototyping, elastic and plastic deformation, and fracture of cast components for optimal geometric design, multi-functions and local material properties.

As described above, it was Volvo and Scania who made the CIC come true. The vehicle programmes are also the backbone of the whole CIC collaboration, and these two companies have been the two absolutely dominating clients of the CIC. This, however, is not seen as a problem: many other member companies of the Swedish Foundry Association are subcontractors to Volvo and Scania and thus benefit from the collaboration as well.

Both companies run projects parallel to the ones within the CIC framework. The other CIC participants do not know very much what these parallel tracks contain; it could be that the participating companies exploit the CIC collaboration more than they actually let on. Generally speaking, though, the CIC collaboration is described as open, and one that has made the companies lower the threshold of what they actually let other companies or actors know; they have realized that the risk of sharing information is less than they feared.

CIC is dedicated to fairly fundamental research, of necessity: the two participating companies are competitors. The CIC projects are designed in a way as not to come too close to those products where the two compete. CIC has no pure consulting activities. According to the managing director of the CIC, this is because there are other actors that provide such services.

Some examples of projects

- **Järnkoll** – stability and robustness in grey iron casting (15 million SEK). Financiers: Volvo Powertrain, Scania and the Vehicle Technology Research Programme
- **Weight efficient light metal structures** – optimal use of aluminium/magnesium (26 million SEK). Financiers: VINNOVA och industrin (Volvo Cars, Volvo Powertrain, EBO, Mönsterås metall, Finnveden Gjutal)
- **Terminal storage of nuclear waste in iron capsules**
- **Optimisation of cast iron components for the wind power industry**
- **Two PhD theses** carried out at the Swedish Foundry Association

These collaborations have not as yet led to the start of spin-off projects, and the activity of CIC today does not differ substantially from that carried out at a typical research centre. The Jönköping University and the Swedish Foundry Association have started collaborating in other areas as a result of the CIC, although to a minor extent. There is now a discussion going on at the University of placing other existing contacts and programs with the Foundry Association under the CIC umbrella.

CIC also collaborates with other universities and industrial research institutes. Together with institutes such as IVF, Mefos and KIMAB, CIC run several projects. The institute also has good relations to universities such as Chalmers, KTH and Linköping, and the CIC manager Ingvar L Svensson furthermore holds a special professorship at the Chalmers University of Technology.

#### Relation to the University sector

The Jönköping University is a foundation, and consists of four separate schools. The operative work is delegated to the board of each school. The Jönköping School of Engineering carries out research and postgraduate studies in five research areas, one of them being component technology. The CIC collaboration is carried out in this research area. All the five research areas at the Jönköping School of Engineering are connected to research institutes; Acreo, Fraunhofer and IVF (twice).

The head of CIC, Ingvar L Svensson, is professor in Foundry Technology focusing on Foundry at the Department of Machine Technology. The department focuses on two areas: component technology (casting) and product development. Of the 35 employees, 26 work with casting. 12 of these are PhD students, all connected to CIC.

The Jönköping School of Engineering considers the CIC collaboration as very positive. The Swedish Foundry Association is a big organisation with many more functions than just research; as a result of the CIC, a group of people within the Association has been identified as collaborators with the University.

#### Funding and resources

CIC is not a legal entity. There are no resources shared by the CIC participants; the incoming money goes to either the University or the Foundry Association and not to the CIC as such. The participating actors have organised their CIC activities separately, and run their own administration within this collaboration.

The resource allocation is described as ”according to the participants' needs”. The growth of the CIC has been organic, and up until now the project plans have been made simply by identifying those who are to take part, and the accounting of economy and staff is done purely on a project basis.

CIC were not allotted any specific resources at the start, and allegedly no budget as such was set up. Now, with the creation of an Institute Excellence Centre *(see Strategy and future perspectives)* this will be structured more strictly.

The CIC manager points out that the work that he does for CIC is not invoiced separately from his other commitments as professor at the Jönköping University. He therefore finds it difficult to specify how much of his time is dedicated to CIC, and even more so since much of what he does for CIC is also beneficial for the University. “It all goes together, we (*at the University department*) don’t do anything that would not fit in with CIC.”

### IPR

Some spin-offs of the CIC collaboration are mentioned by some interviewees

- One spin-off company from the University – Tixo Casting
- Scania is closing down in Sibbhult (Skåne), and instead starting a casting plant. This activity has its origins in CIC
- The Foundry Association has applied for a patent on a technology together with Volvo. This, according to the CIC manager, is a clear effect of CIC
- Future processes of Casting, together with Scania (although this is a project that started before the creation CIC)
- Volvo Skövde has increased production fast, and taken market shares from Renault and Mach. Again, according to the CIC manager this is as a result of CIC.

It is too early to say what effects the creation of CIC has had on research and education at the Jönköping University. There are still no clear signs that the collaboration has affected the direction or content of the research, and it has still not affected the basic education. From the University, this is explained by the fact that CIC was created in close collaboration with industry, and with the latter driving the agenda.

In the same vein, CIC has not yet produced direct spin-offs for other companies, although this, according to one person interviewed, will be the case in the future. Volvo and Scania are described as having a positive attitude in this respect; some of these potential beneficiaries are their subcontractors.

### Strategy and future perspectives

The first step in creating an improved R&D environment was taken in 1995 when the Swedish Foundry Association and the Swedish automotive industry together endowed the professorship in casting technology. The second step was to concentrate research by creating CIC in 2004. The third step is now about to be taken, with the creation of an Institute Excellence Centre.

The Swedish Foundry Association presented a proposal to VINNOVA, KK Foundation and the Swedish Foundation for Strategic Research for an Institute Excellence Centre within the CIC. This proposal was accepted, and this means the collaboration through Casting Innovation Centre will be upgraded from autumn 2006 when the CIC Excellence Centre officially starts.

The Swedish Foundry Association is the signing part in this Excellence Centre in which the Jönköping University of Engineering/ Jönköping University, Volvo and Scania are also partners. According to the instructions, this initiative shall lead to internationally strong environments for research, development and innovation in areas of great importance for Sweden's future competitiveness and growth.

The CIC Excellence Centre could in this way become a complement to the universities, as an important knowledge node in order to develop Swedish research and for the Swedish companies to strengthen their competitive edge.The CIC Excellence Centre will get up to 40 million SEK during the coming six years from the financiers, on the condition that industry matches this with at least as much. The Jönköping University of Engineering will put in some 3 million SEK a year, and participating companies will invest the same amount. This will lead to a budget of some 12-13 million SEK/year. The Excellence Centre is primarily directed towards senior researchers, but the idea is to strengthen the centre with PhD students.

The Excellence Centre means that the collaboration in CIC will be expanded to some 15 companies. The increased budget and a clearer administrative leadership will make that possible. The centre will be concerned primarily with material and process development, and four main areas of research have been identified

- Trucks and lorries
- Light weight (cars)
- Wind power (Vestas, Metso and others)
- Combinations of materials

The present head of R&D at the Swedish Foundry Association will now step down from that post in order to manage the Excellence Centre. The Swedish Foundry Association will appoint a new head of R&D. The professor of casting technology at the Jönköping University, and present manager of CIC, will be the chief scientist of the new centre. The Centre will be set up by a "Consortium Council" in which all partners are represented. The steering committee will include five members from industrial partners, two from SFA (including one director), three of the new programme co-ordinators, and one member from Jönköping University.

The ambition is that this strengthened and more formalized collaboration between the Foundry Association and Jönköping University will be compatible with collaboration with other institutes and universities, when the need arises. The Foundry Association is already a part of the Swerea group, and the collaboration with Chalmers is likely to become even closer now that the CIC manager professor Ingvar Svensson is formally attached to that university.

# VINNOVA´s publications

**May 2007**

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## VINNOVA Analysis

### VA 2007:

01 Nanoteknikens innovationssystem

02 Användningsdriven utveckling av IT i arbetslivet - Effektvärdering av tjugo års forskning och utveckling kring arbetslivets användning av IT. *For brief version in Swedish and English see VA 2007:03 and VA 2007:13*

03 Sammanfattning - Användningsdriven utveckling av IT i arbetslivet - Effektvärdering av tjugo års forskning och utveckling kring arbetslivets användning av IT. *Brief version of VA 2007:02, for brief version in English see VA 2007:13*

04 National and regional cluster profiles - Companies in biotechnology, pharmaceuticals and medical technology in Sweden 2004. *Only available as PDF. For Swedish version see VA 2005:02*

05 Nationella och regionala klusterprofiler - Företag inom fordonsindustrin i Sverige 2006

06 Behovsmotiverade forskningsprogram i sektoriella innovationssystem

07 Effekter av den svenske trafikksikkerhetsforakningen 1971-2004. *For brief version in Swedish and English see VA 2007:08 and VA 2007:09*

08 Sammanfattning - Effekter av den svenska trafiksäkerhetsforskningen 1971-2004. *Brief version of VA 2007:07, for brief version in English see VA 2007:09*

09 *Under production.*Summary - Effects of Swedish traffic safety research 1971-2004. *Brief version of VA 2007:10, for brief version in Swedish see VA 2007:07.*

10 *Under production.* Effects of Swedish traffic safety research 1971-2004. *For brief version in Swedish and English see VA 2007:08 och VA 2007:09*

11 Svenskt deltagande i sjätte ramprogrammet. *Only available as PDF*

12 The role of Industrial Research Institutes in the National Innovation System

13 Summary - User-driven development of IT in working life - Evaluating the effect of research and development on the use of information technology in working life. *Brief version of VA 2007:02, for brief version in Swedish see VA 2007:03*

### VA 2006:

01 End of an era? Governance of Swedish innovation policy. *For Swedish version see VA 2005:07*

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02 Nationella och regionala klusterprofiler - Företag inom bioteknik, läkemedel och medicinsk teknik i Sverige 2004. *For English version see VA 2007:04*

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04 Effektanalys av nackskadeforskningen vid Chalmers - Sammanfattning. *Brief version of VA 2004:07, for brief version in English see VA 2005:05*

05 Impacts of neck injuries research at Chalmers University of Technology - Summary. *Brief version of VA 2004:07, for brief version in Swedish see VA 2005:04*

06 Forskningsverksamhet inom produktframtagning i Sverige - en ögonblicksbild år 2004

07 En lärande innovationspolitik - samordning och samverkan? *For English version see VA 2006:01*

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## VINNOVA Forum

### VFI 2007:

01 Universitetet i kunskapsekonomin *(Innovation policy in Focus)*

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### VI 2007:

01 Forska&Väx - Program som främjar forskning, utveckling och innovation hos små och medelstora företag

02 MERA-programmet - Projektkatalog. *For English version see VI 2007:03*

03 The MERA-program - Projects. *For Swedish version see VI 2007:02*

04 DYNAMO 2 - Startkonferens & Projektbeskrivningar

05 IT för sjukvård i hemmet - Projektkatalog

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### VI 2006:

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02 In search of innovation systems. *For Swedish version see VP 2006:01*

### VP 2005:

01 Kunskap för säkerhets skull. Förslag till en nationell strategi för säkerhetsforskning. *For English version see VP 2005:03*

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by funding needs-driven research
and developing effective innovation systems

VERKET FÖR INNOVATIONSSYSTEM – SWEDISH GOVERNMENTAL AGENCY FOR INNOVATION SYSTEMS

VINNOVA, SE-101 58 Stockholm, Sweden Besök/Office: Mäster Samuelsgatan 56
Tel: +46 (0)8 473 3000 Fax: +46 (0)8 473 3005
VINNOVA@VINNOVA.se www.VINNOVA.se